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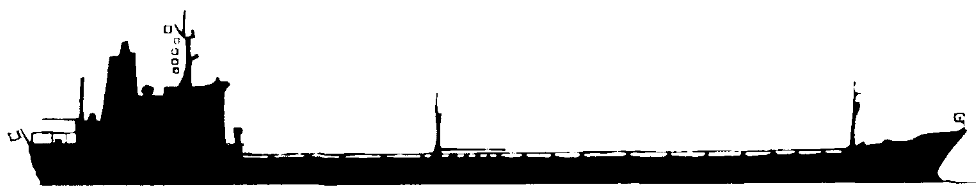
Port Needs Study (Vessel Traffic Services Benefits)

Volume II: Appendices, Part 1

Research and Special Programs
Administration
John A. Volpe National
Transportation Systems Center
Cambridge MA 02142-1093

August 1991



U.S. Department
of Transportation

**United States
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Office of Navigation Safety and Waterway Services
Washington DC 20593

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16. Abstract

This study documents the benefits and costs of potential U.S. Coast Guard Vessel Traffic Services (VTS) in selected U.S. deep water ports on the Atlantic, Gulf and Pacific Coasts. The U.S. Department of Transportation's Research and Special Programs Administration's Volpe National Transportation Systems Center (VNTSC) conducted the study for the U.S. Coast Guard, Office of Navigation Safety and Waterway Service, Special Projects Staff. The entire study is documented in three separately bound volumes plus a separate Study Overview. Volume I is the main document covering all aspects of the input data, analysis methods, and results. The focus of Volume I is presentation of information across all 23 study zones concurrently. Volume II focuses on organization and presentation of information for each individual study zone. It contains the appendix tables of input data, output statistics and the documentation of the candidate Vessel Traffic Services (VTS) Design by NavCom Systems. Volume III is a compendium of technical papers on data sources, analytical methods, and models supplementing material in Volume I.

It includes appendices A through K. Vessel types and sizes, surveillance methods, marine risk, and types of accidents and casualties are listed.

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METRIC / ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32) (5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5	6	7	8	9	10

CENTIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 | 25.40

QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and/or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10 286.

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BOSTON, MA

(ZONE 1)

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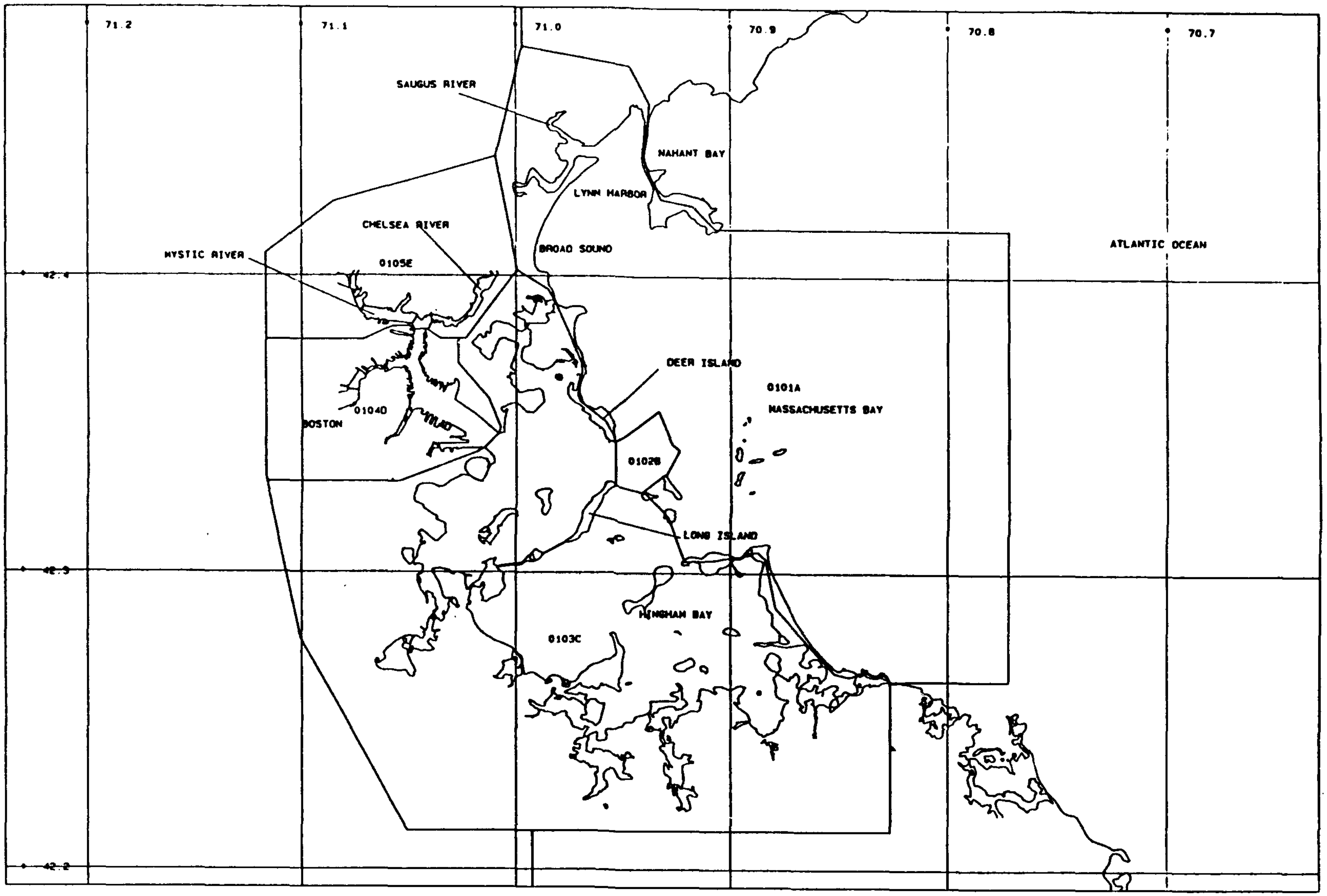
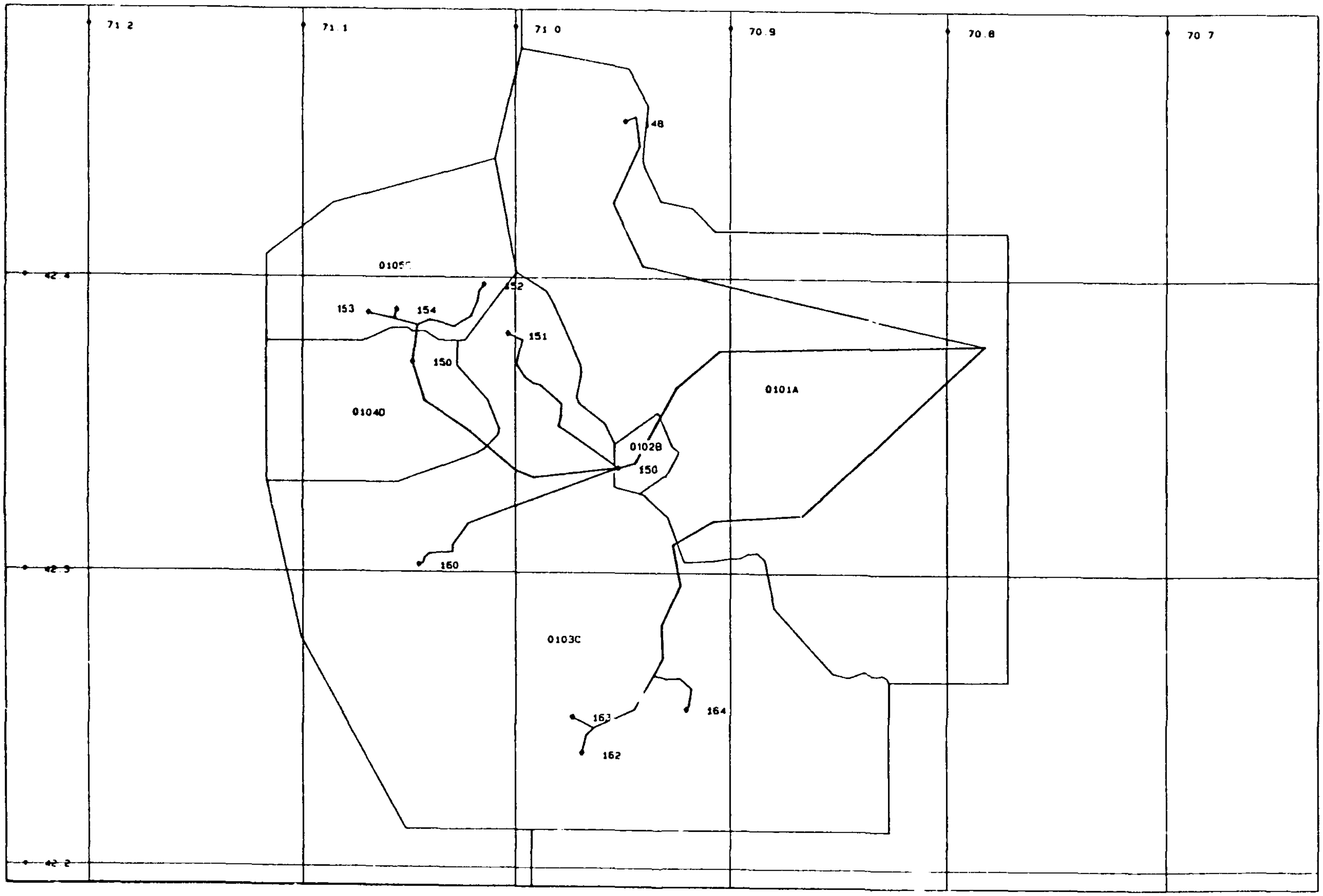
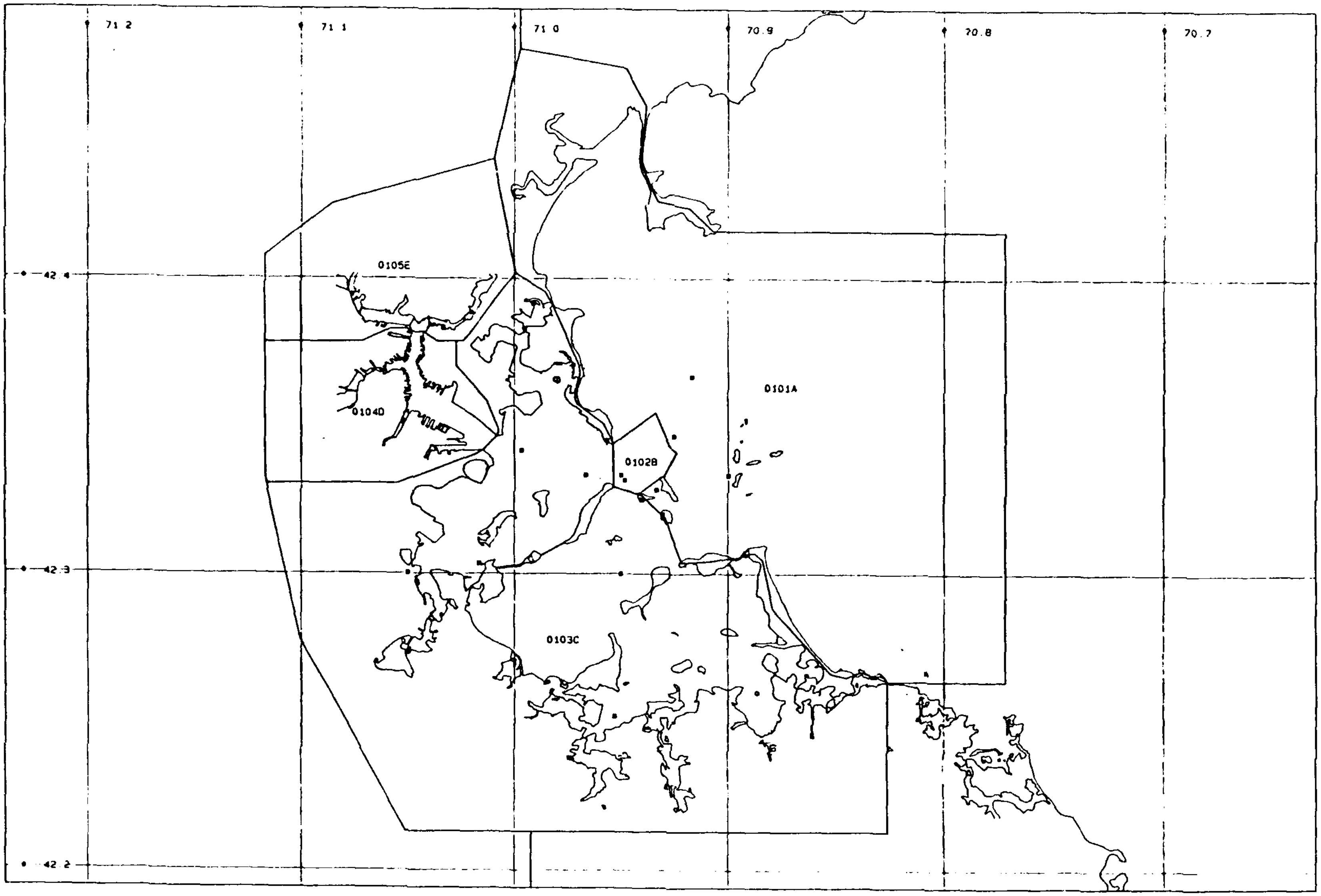
STUDY ZONE MAPS



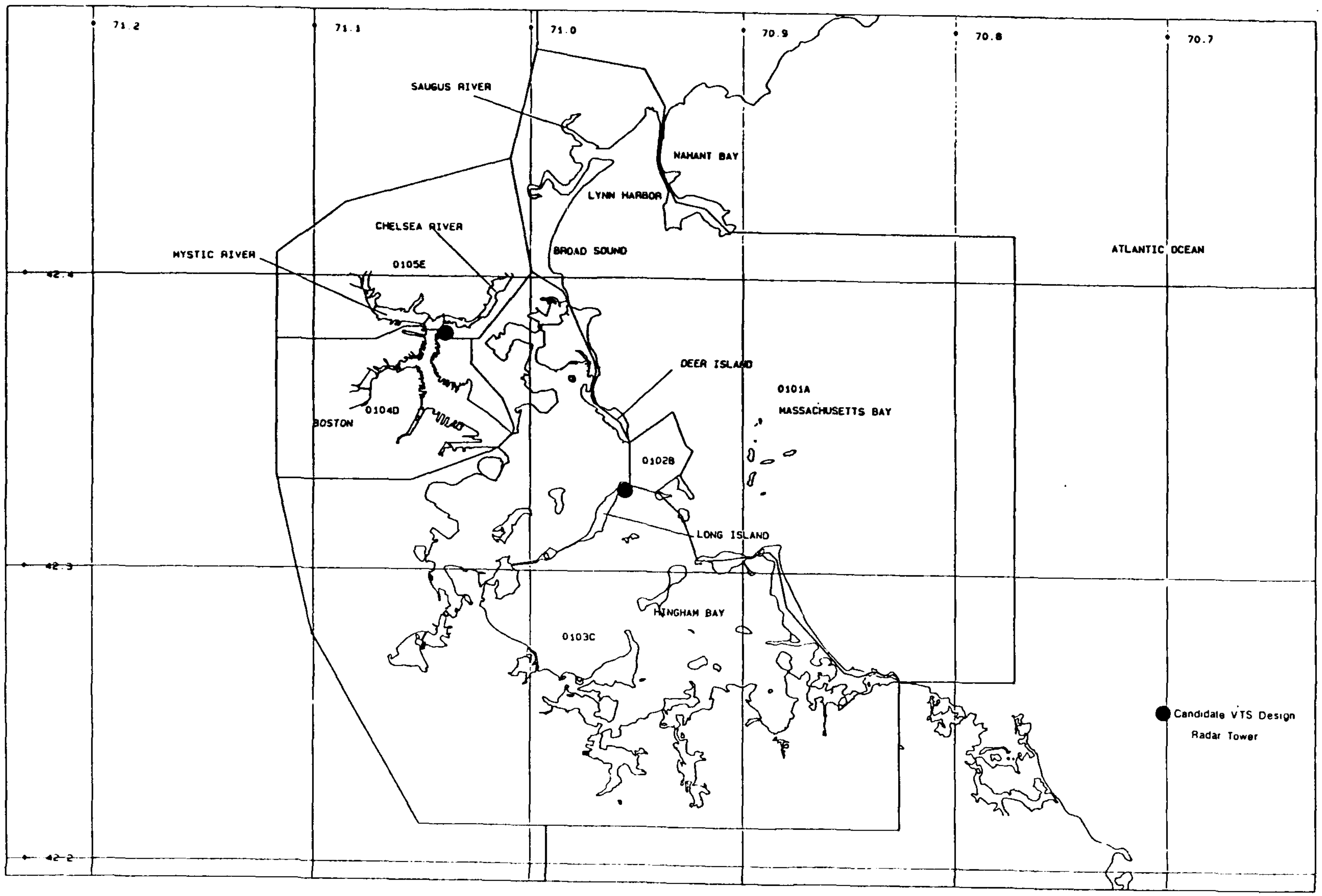
ZONE 1 - BOSTON, MA - ZONE AND SUBZONE BOUNDARIES



ZONE 1 - BOSTON, MA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 1 - BOSTON, MA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 1 - BOSTON, MA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

BOSTON, MA

(ZONE 1)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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BOSTON HARBOR VESSEL TRAFFIC SERVICES (VTS) DESIGN

1.0 INTRODUCTION

A detailed survey of Boston Harbor in May of 1990 resulted in the formulation of a preliminary Vessel Traffic Services (VTS) system design for the area. The final Boston Harbor VTS design as submitted in this report is based on further physical examination of the area's features and facilities. A new approach to costing VTS systems in outlined in Vol. III, Technical Supplement and a new method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The five sub-zones defined in the original Boston Harbor survey report remain the same.

The hardware and software selected for this design provides the level of surveillance justified by the problems identified and the casualty history in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

1.1 VTS DESIGN APPROACH

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o The accuracy of the position and track obtained

- o The reliability of the surveillance system
- o The timeliness of the data obtained
- o The ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore (ADS). The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o How many vessels interact in this sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, is the additional information obtained from ADS over position reporting necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o Choosing a specific ADS solution for one sub-zone in one harbor may effect all the VTS designs for all the other sub-zones in all the other harbors.

1.2 ASSUMPTIONS

The system design for the Boston VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumption are as follows:

o The weather is variable from season to season. There are numerous foggy periods and occasional strong winds. Very heavy rain is rare but there are periods of snow in winter.

o The traffic density is light but the existing traffic is energy intensive.

o The accident rate in this harbor is low.

o The physical dimensions of this harbor are very small, encompassing less than 100 square miles.

o As recommended by the IMO, all vessels of 20 meters or more in length will be required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o Most of the energy terminals are located in the narrow Chelsea River area.

o Future ferry traffic from Logan Airport to downtown Boston will increase.

o Enforcement of harbor procedural regulations is limited.

- o There is no national standard to which each ADS device must conform so that its data can be used in any sub-zone in any port.

2.0 DESIGN DECISIONS

2.1 GENERAL

Because the Boston Harbor has a good safety history and low traffic density, it may appear that an active communications/procedural VTS system would adequately protect the area. However, a more extensive system has been chosen for the following reasons:

- o The port is energy intensive and vulnerable to a significant spill with major ecological damage and public impact. A serious energy accident in Boston Harbor has the potential to impact the economy of all of New England.

- o The area surrounding Deer Island contains four closely coupled problems areas, will be subject to increased local traffic over the next decade as the Deer Island sewage plant is built, and contains a large federal anchorage with no real-time system of compliance monitoring.

- o Because of its narrow nature and two drawbridges, the Chelsea River, which contains most of the petroleum terminals, is a very difficult area to navigate and requires close, real-time monitoring.

A study of the traffic flow and problem areas requiring surveillance leads to the selection of two VTS control sectors for this harbor. Sector I is made up of Sub-zones I, II and III and Sector 2 is made up of Sub-zones IV and V. A single VTS communications frequency is sufficient because the small size of the Boston VTS zone and the light traffic level will not cause communications interference problems or operational confusion between sectors. The VTS communications capability is to be implemented with low radiated power level (1 watt) sites to reduce interference. The existing VHF high radiated power level (>10 watts) site on the Boston Bank Building is to have another transmitter installed for use by the VTC as needed. The VTC logically belongs at the U.S. Coast Guard Support Center, Boston because of its central location in the Inner Harbor and its excellent support facilities. The best location inspected is on the southeast corner of the roof of Building 8. Figure 2-1 is a summary of the surveillance chosen for the Boston VTS zone. Figure 2-2 represents the final system design in block diagram form.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-zone II
II	1									1	1		1						
III																			Comms/Radar Coverage From Sub-Zones II,V
IV											1								Radar/Comms coverage from Sub-Zones II, V
V	1									1			1						Position Sensors On Chalsea River Draw Bridges

FIGURE 2-1. BOSTON, MA, HARBOR SURVEILLANCE SURVEY

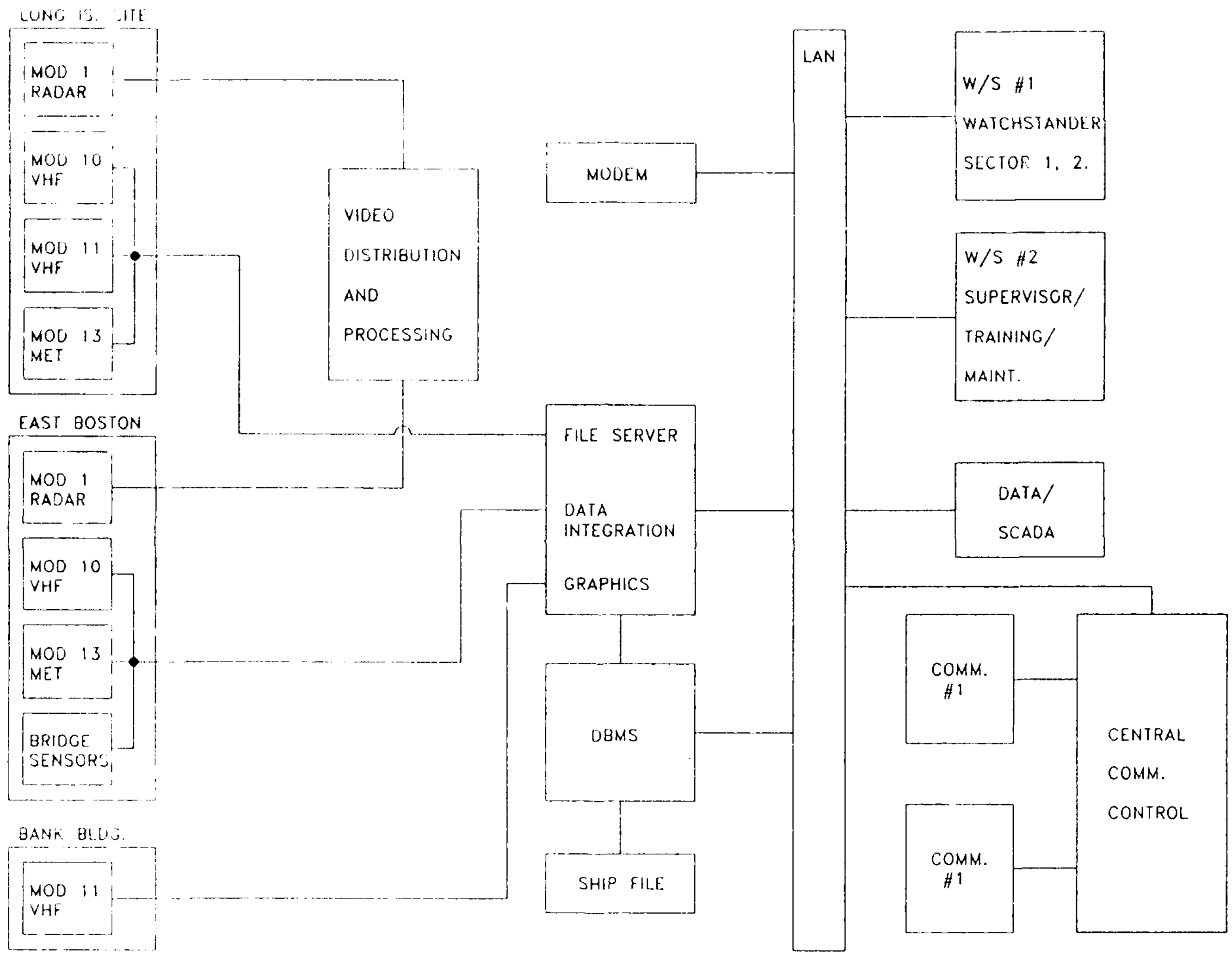

FIGURE 2-2. BOSTON, MA, VTS BLOCK DIAGRAM

2.2 SUB-ZONE I -- HARBOR APPROACHES

2.2.1 Discussion

This large area outside of the COLREGS line includes part of the precautionary area and the offshore approaches to Boston Harbor. Due to the unstructured and unpredictable nature of the traffic patterns, this area is designated as "open-complex." Since vessels in this sub-zone are not required to monitor Channel 13 (Bridge-to-Bridge communications), the only existing procedural rules are the established Traffic Separation schemes. VTS implementation entails procedural changes which require ships entering Boston Harbor to report to the VTS center prior to entering the precautionary area. Discussions with pilots indicate that neither the volume of traffic nor the existing traffic patterns in this area create a problem in identifying vessels by radar and voice communications. Therefore, a direction finder (VHF/DF) facility is not required. The active radar surveillance addressed in Paragraph <u>2.3 Sub-zone II</u> coincidentally provides surveillance of the precautionary area.

2.2.2 Design

The VTS technological solution chosen for this sub-zone is dependent in nature. Complete communications coverage and expanded procedural reporting is selected. No hardware is installed in this area. The required communications coverage is provided by the facility in Sub-zone II. Active surveillance of the precautionary area is provided from the radar in Sub-zone II.

This area lends itself to use of a vessel-based surveillance system if it becomes necessary to have more data on vessels headed for Boston Harbor. There are no port planning problems now. If, however, a national or international requirement emerges for the carriage of ADS devices on deep draft vessels, this sub-zone represents one area where such data could be employed. Since this area is well outside of the harbor pilots' ship boarding stations, a carry-on type of ADS device is impractical.

2.3 SUB-ZONE II -- BOSTON OUTER HARBOR

2.3.1 Discussion

Sub-zone II is a "confined complex" area of approximately 36 square miles. This sub-zone includes part of the precautionary area, the main entrance channels into the inner harbor and a large federal anchorage adjacent to the channel inside Deer Island. Four problem areas are confined within a three-mile radius of Deer Island Light. These closely coupled and interactive problem areas create one single area of major concern within this sub-zone. Another problem noted in this sub-zone involves the Deer Island sewer project. In the next decade a significant amount of waterborne traffic will

develop to serve this sewer project. Much of this traffic will originate in Dorchester Bay and will therefore be confined to Sub-zone II.

Due to the number of problem areas in the vicinity of Deer Island, however, surveillance radar is necessary. This radar coincidentally provides surveillance for the entire sub-zone. The main vessel interactions of concern in the area are:

- o Ship/ship interactions in and around the federal anchorage

- o Ship/local traffic interactions in the channel and at channel intersections. Local traffic is mainly tug/barge, fishing, passenger for hire, Deer Island traffic and recreational vessels.

- o Ship navigation in the main channel

Deer Island and Long Island were the two locations initially selected for the radar installation. On-site investigation of the ongoing Deer Island Project indicates that Long Island is a better choice. The extensive sewer project construction on Deer Island for the next decade will entirely re-shape the Island and create large structures in many locations. There are many possible radar site locations on Long Island which provide excellent coverage of the problem areas. These include Long Island Head, Long Island Light, and several hospital buildings. The Long Island Head site is preferred because it affords better coverage of the Hull Gut area in Sub-zone III. Excellent coverage is also afforded to Dorchester Bay where a great deal of the Deer Island traffic originates. To limit communications interference and to insure the availability of metereological data, a low radiated power level communications facility is to be co-located with the radar site as well as a complete meteorological sensor suite. Current and water depth are not significant navigational obstacles in this area and need not be monitored.

2.3.2 Design

A Module 1 radar installation is selected based on the conclusion that this radar can provide sufficient resolution at the ranges involved and that the weather does not warrant a lower frequency radar. Total communications coverage is to be provided by a new communications site on Long Island. Both medium and low power must be available in order to service Sub-zones I, II, and III. This site is to be capable of transmitting/receiving on Channel 16, Channel 13, the VTS channel and the pilot channel. It is also to have a guard receiver on Channel 16. A complete metereological sensor suite to measure wind velocity/direction, air temperature and visibility (Module 13) is to be co-located with the radar/communications facility on Long Island.

Dependent surveillance type systems are not recommended in this sub-zone for several reasons. To provide monitoring of the pertinent vessel interactions, all three classes of vessels down to 20-meters, i.e. oceangoing, coastal, and local, would have to be equipped. This is untenable. In addition, update rates of less than 10 seconds would periodically be required of all vessels in the problem areas to adequately monitor the vessel interactions as they develop, and, finally, a fail safe back-up would be required.

2.4. SUB-ZONE III -- SOUTH HARBOR

2.4.1 Discussion

The navigable portion of this sub-zone comprises about 20 square miles to the south of President Roads. This sub-zone is considered to be "confined-complex" because the channels are quite narrow and a large amount of recreational boating can occur. Very little seagoing traffic traverses this sub-zone. Hull Gut is a problem area due to its narrow width and strong tidal currents.

2.4.2 Design

The overall technological solution chosen for this sub-zone is dependent in nature. Active communications monitoring of the existing procedural rules is supplemented by increased reporting requirements. This selection is based on the nature and frequency of the traffic in the sub-zone and the lack of significant shipping interactions or navigational difficulties. The Hull Gut problem area is adequately covered by the radar site established for Sub-zone II. Communications in this zone can be adequately provided by the communications site on Long Island. No hardware is necessary. Active surveillance is provided coincidentally by the radar installation in Sub-zone II for the entire sub-zone except for those areas shadowed by land.

Any information obtained from ADS equipped ocean-going vessels in this sub-zone would be useful to the VTS but is not required to manage this area. This data could be used to verify the reported positions.

2.5 SUB-ZONE IV -- BOSTON INNER HARBOR

2.5.1 Discussion

This "confined-complex" sub-zone encompasses all of what is commonly known as Boston Harbor. There are very few navigational hazards, the water is of adequate depth except outside of the channel near Logan Airport, and the channels are quite wide. The major shipping problem involves interaction of fishing vessels and other small craft with deep draft vessels. One problem unique to this sub-zone is the interaction of ships in the channel and airplanes landing at Logan Airport on Runway Four Right. If a ship

with a masthead height of over 85-feet enters the area off of Runway Four Right, planes are warned to make a higher than normal approach. The FAA currently monitors this area with its ground control radar and closed circuit television cameras mounted on the west side of the channel. The cameras have optical reticles that allow measurement of masthead height when the ships can be seen. In order to measure height of ships in low visibility, the FAA is investigating a millimeter wave radar capability to directly measure mast height in all weather. Dependence on Lloyd's List for ship heights and communication with ship pilots alone are not sufficient methods of obtaining the extremely reliable, measured system required by the FAA. It is FAA policy that they will measure ship heights with their own system as part of the approach monitoring for the airport and that they will not rely on an existing VTS system. Logan Airport is scheduled to receive a new ground control radar in February of 1991. The established VTS control center should be coordinated with the FAA to determine areas of mutual benefit and data needs because data interchange on ship identification, location, and expected arrival time in their zone of concern would be useful.

2.5.2 Design

The overall technological solution chosen for this sub-zone is dependent in nature. Active communications monitoring of the existing procedures and the addition of new procedural reporting requirements is selected. The radar facilities in Sub-zones II and V coincidentally provide excellent coverage of this entire area. Procedural reporting and active communications coverage are choices based on existing traffic levels, accident history and the physical configuration of the sub-zone. The navigational hazards are few and adequate maneuvering room exists due to good water depths right up to the pier heads. The procedural change is a required departure notice on the VTS communications frequency for all ferries crossing the Inner Harbor so that the VTC and all other vessels are alerted to their movements. No significant VTS gains are envisioned by utilizing information from the existing or planned surveillance sensors at Logan Airport. Hardware includes additional transceivers at the existing high radiated power level communications site on the Boston Bank Building.

ADS data from deep draft vessels so equipped would be of minimal value in this sub-zone because the interactions of concern are between ocean-going and local vessels. This requires that all vessels over 20 meters in the sub-zone be equipped with ADS devices, an untenable situation. There is complete radar coverage of this sub-zone from the radar sites in Sub-zones II and V if the need arises for active surveillance.

2.6 SUB-ZONE V -- BOSTON RIVERS

2.6.1 Discussion

Ship handling in this "confined-complex" sub-zone is the most difficult in the harbor. This area also contains a liquefied natural gas (LNG) terminal and the majority of petroleum terminals. The Chelsea River with its two drawbridges, one-way traffic and very narrow channels is the most hazardous. The difficulty of navigating vessels through the narrow bridges and channels demands that chance encounters with other traffic be eliminated. The turning basin at the junction of the Chelsea and Mystic Rivers is also a potentially troublesome area if other traffic is encountered. The LNG vessels are turned in this basin and backed under the Tobin Bridge into the Mystic River by tug boats. There is also a large container terminal in the Mystic River which is served by sizeable container ships.

2.6.2 Design

The overall technological solution selected for this sub-zone is active radar surveillance, communications coverage and the existing procedural rules. The rationale for this selection is as follows:

- The majority of the petroleum terminals in Boston Harbor are in this sub-zone.

- The waters are narrow and represent a significant navigation problem where unexpected vessel interactions must be eliminated.

- The one-way traffic in the Chelsea River must be actively monitored to insure compliance with existing procedures and detect any unannounced movements. This traffic is composed of both tugs and barges and larger ships.

- LNG carrier maneuvers in the turning basin and under the Tobin Bridge present the possibility for a serious accident.

A physical survey of the area indicates that the preferred location for a radar site is on top of the Shore Plaza East buildings at the corner of Border and Falcon Streets in East Boston. The east side of the upper deck of the Tobin Bridge is an alternative site. This site, however, gives no coverage of the Mystic River terminals. A low radiated power level communications site and complete meteorological suite are co-located with this radar. Bridge sensors which indicate whether the McCardle and/or Chelsea Drawbridges are open are to be placed on both bridges as an added safeguard. No traffic of significant size can exit the Chelsea River into the turning basin when these bridges are closed.

A Module 1 radar installation is selected based on the detection and tracking ranges involved and the physical configuration of the waterways. Co-located with this installation is a low radiated power level communications facility (Module 10) and a complete meteorological sensor suite capable of measuring visibility (Module 13). The communications equipment is capable of transmitting and receiving on Channel 16, Channel 13, the VTS channel and the pilot channel. It is also to have a guard receiver on Channel 16.

An ADS system is inappropriate because it would be necessary to equip all types of vessels. The most serious concern in this sub-zone is surprise or unannounced vessel movements.

2.7 VESSEL TRAFFIC CENTER

The design of the hardware and software should be modern and capable of operating with reduced staff levels without loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is to be located at the U.S. Coast Guard Support Center in Boston in a location with good visual surveillance of the Boston Inner Harbor. The center is to employ the following equipment:

2.7.1 VTS console

This console provides total data integration from all sensors in both sectors. These data are graphically shown on at least two raster scan, high light level displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- Software written in a high level language.

- Software providing the total integration of data from all VTS sensors.

- Layering of data in at least four layers.

o The ability to sector data including sector to sector handoff of targets.

o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor will be provided. Additional warning and/or alarm features allowed by programming changes in high level language.

o Complete modern color graphics capability with offset and zoom.

o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

o The ability to de-select stationary targets. In the vicinity of Deer Island and in the entrance to the channel, lobster pot and fish net returns cause clutter in calm weather.

2.7.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allow monitoring and transmission on all required frequencies. The console provides two operating positions each to be capable of complete communications control.

It is capable of modular expansion if other remote communications sites are added.

2.7.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided as Figure 2-2 indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

2.7.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

3.0 COST ESTIMATES

3.1 General

Vol. II, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Boston VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Para. 1.2.

3.2 Hardware

VESSEL TRAFFIC CENTER	(x $1000) Non-recurring	10-yr. Recurring
VTS Console (w/all software)	$ 500	
Comms Console	100	
Recording Equipment--2 sets	50	
SCADA Equipment--2 radar sites	100	
SUB-TOTAL	$ 750	$375
SECTOR 1, SECTOR 2		
Long Island Site		
Module 1 Radar	310	310
Module 10 VHF	19	13
Module 11 VHF	48	20
Module 13 Met	40	5
East Boston Site		
Module 1 Radar	310	310
Module 10 VHF	19	13
Module 13 Met	40	5
Drawbridge Sensors	10	1
Boston Bank Building		
Module 11 VHF	48	20
SUB-TOTAL:	$ 844	$ 697
TOTAL HARDWARE COST:	$1594	$1072

3.3 Total Project Costs (x$1000)

Hardware	$1594
Management, Engineering, etc. (70%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1115
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no problem	319
Spares & Training (10%)	160
Civil Engineering Assumptions: Building modification at Support Center Boston, Comm, towers, 2 remote radar buildings, land acquisition	1500
PROJECT ESTIMATE:	$4688
Data Base Management System	300
TOTAL: (non-recurring)	$4988

TEN-YEAR O&M RECURRING

Hardware	1072
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL; (recurring) (10-year life)	$4572
TOTAL 10-YEAR PROJECT COST:	$9560

GLOSSARY

ADS: Automatic Dependent Surveillance
"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Candian Coast Guard, Ottawa, October 1984, pp.89-91.
"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interations between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.
CCTV: closed circuit television
COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.
CPA: closest point of approach
DBMS: data base management system
DF: direction finder
FAA: Federal Aviation Administration
GIS: Geographic Information System
IMO: International Maritime Organization
LAN: local area network
LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.
LNG: liquified natural gas
"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.
"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.
PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable
SCADA: Supervisor Control and Data Acquisition
TCPA: time of closest point of approach
TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.
VHF: very high frequency
VTC: vessel traffic center
VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix A   Zone 1   Boston, MA

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone 101A		
148	A	LYNN HARBOR, MASS.
150	A	MAIN WATERFRONT
151	A	WINTHROP HARBOR, MASS.
152	A	CHELSEA RIVER, MASS.
153	A	MYSTIC RIVER, MASS.
154	A	ISLAND END RIVER, MASS,
160	A	DORCHESTER BAY, MASS.
162	A	WEYMOUTH FORE RIVER, MASS.
163	A	TOWN RIVER, MASS.
164	A	WEYMOUTH BACK RIVER, MASS.
Subzone 102B		
150	A	MAIN WATERFRONT
151	A	WINTHROP HARBOR, MASS.
152	A	CHELSEA RIVER, MASS.
153	A	MYSTIC RIVER, MASS.
154	A	ISLAND END RIVER, MASS,
160	A	DORCHESTER BAY, MASS.
Subzone 103C		
150	A	MAIN WATERFRONT
151	A	WINTHROP HARBOR, MASS.
152	A	CHELSEA RIVER, MASS.
153	A	MYSTIC RIVER, MASS.
154	A	ISLAND END RIVER, MASS,
160	A	DORCHESTER BAY, MASS.
162	A	WEYMOUTH FORE RIVER, MASS.
163	A	TOWN RIVER, MASS.
164	A	WEYMOUTH BACK RIVER, MASS.
Subzone 104D		
150	A	MAIN WATERFRONT
152	A	CHELSEA RIVER, MASS.
153	A	MYSTIC RIVER, MASS.
154	A	ISLAND END RIVER, MASS,
Subzone 105E		
152	A	CHELSEA RIVER, MASS.
153	A	MYSTIC RIVER, MASS.
154	A	ISLAND END RIVER, MASS,

Appendix A Zone 1 Boston, MA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 101A MASSACHUSETTS BAY

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	12,625	0	0	0	12,625
2	FOREST PRODUCTS	2,063	0	0	0	2,063
3	FISHERIES PRODUCTS	62,868	0	0	0	62,868
4	MINING PRODUCTS, NEC	285,102	0	0	0	285,102
5	PROC. FOODS & MFTRS, NEC	2,012,001	0	9,954	0	2,021,955
6	WASTE OF MANUFACTURING	675,440	0	0	0	675,440
1311	CRUDE PETROLEUM	0	63,462	0	5,867	69,329
2811	CRUDE PROD-COAL TAR-PET	2,590	0	0	0	2,590
2813	ALCOHOLS	0	183	0	21	204
2817	BENZENE AND TOLUENE	0	1,551	0	131	1,682
2871	NITROGEN CHEM FERTILIZER	5	0	0	0	5
2911	GASOLINE, INCL NATURAL	0	4,960,958	0	594,610	5,555,568
2912	JET FUEL	0	956,908	0	115,868	1,072,776
2913	KEROSENE	0	115,387	0	45,375	160,762
2914	DISTILLATE FUEL OIL	0	5,150,558	0	1,094,616	6,245,174
2915	RESIDUAL FUEL OIL	0	3,847,622	0	762,786	4,610,408
2916	LUBRIC OILS-GREASES	0	93,222	0	14,283	107,505
2921	LIQUI PETR-COAL-NATR GAS	1,190	0	0	0	1,190
2922	Special VTS LNG Category	0	41,174	0	0	41,174
	Subzone Total :	3,053,884	15,231,025	9,954	2,633,557	20,928,420

Subzone 102B CONVERGENCE AREA

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	12,521	0	0	0	12,521
2	FOREST PRODUCTS	2,063	0	0	0	2,063
3	FISHERIES PRODUCTS	62,845	0	0	0	62,845
4	MINING PRODUCTS, NEC	281,590	0	0	0	281,590
5	PROC. FOODS & MFTRS, NEC	1,928,143	0	9,954	0	1,938,097
6	WASTE OF MANUFACTURING	675,440	0	0	0	675,440
1311	CRUDE PETROLEUM	0	63,462	0	5,867	69,329
2811	CRUDE PROD-COAL TAR-PET	2,590	0	0	0	2,590
2813	ALCOHOLS	0	183	0	21	204
2817	BENZENE AND TOLUENE	0	1,551	0	131	1,682
2871	NITROGEN CHEM FERTILIZER	5	0	0	0	5
2911	GASOLINE, INCL NATURAL	0	4,155,632	0	541,166	4,696,798
2912	JET FUEL	0	955,840	0	115,868	1,071,708
2913	KEROSENE	0	113,680	0	38,921	152,601
2914	DISTILLATE FUEL OIL	0	4,793,813	0	825,123	5,618,936
2915	RESIDUAL FUEL OIL	0	3,773,673	0	728,784	4,502,457
2916	LUBRIC OILS-GREASES	0	93,222	0	14,283	107,505
2921	LIQUI PETR-COAL-NATR GAS	1,190	0	0	0	1,190
2922	Special VTS LNG Category	0	41,174	0	0	41,174
	Subzone Total :	2,966,387	13,992,230	9,954	2,270,164	19,238,735

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 103C BOSTON HARBOR

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	12,625	0	0	0	12,625
2	FOREST PRODUCTS	2,063	0	0	0	2,063
3	FISHERIES PRODUCTS	62,868	0	0	0	62,868
4	MINING PRODUCTS, NEC	285,102	0	0	0	285,102
5	PROC. FOODS & MFTRS, NEC	2,012,001	0	9,954	0	2,021,955
6	WASTE OF MANUFACTURING	675,440	0	0	0	675,440
1311	CRUDE PETROLEUM	0	63,462	0	5,867	69,329
2811	CRUDE PROD-COAL TAR-PET	2,590	0	0	0	2,590
2813	ALCOHOLS	0	183	0	21	204
2817	BENZENE AND TOLUENE	0	1,551	0	131	1,682
2871	NITROGEN CHEM FERTILIZER	5	0	0	0	5
2911	GASOLINE, INCL NATURAL	0	4,960,958	0	594,610	5,555,568
2912	JET FUEL	0	955,840	0	115,868	1,071,708
2913	KEROSENE	0	115,387	0	45,375	160,762
2914	DISTILLATE FUEL OIL	0	5,150,558	0	1,094,616	6,245,174
2915	RESIDUAL FUEL OIL	0	3,847,622	0	762,786	4,610,408
2916	LUBRIC OILS-GREASES	0	93,222	0	14,283	107,505
2921	LIQUI PETR-COAL-NATR GAS	1,190	0	0	0	1,190
2922	Special VTS LNG Category	0	41,174	0	0	41,174
	Subzone Total :	3,053,884	15,229,957	9,954	2,633,557	20,927,352

Subzone 104D BOSTON INNER HARBOR

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	12,521	0	0	0	12,521
2	FOREST PRODUCTS	2,063	0	0	0	2,063
3	FISHERIES PRODUCTS	62,845	0	0	0	62,845
4	MINING PRODUCTS, NEC	281,590	0	0	0	281,590
5	PROC. FOODS & MFTRS, NEC	1,928,143	0	9,954	0	1,938,097
6	WASTE OF MANUFACTURING	675,440	0	0	0	675,440
1311	CRUDE PETROLEUM	0	63,462	0	5,867	69,329
2811	CRUDE PROD-COAL TAR-PET	2,590	0	0	0	2,590
2813	ALCOHOLS	0	183	0	21	204
2817	BENZENE AND TOLUENE	0	1,551	0	131	1,682
2871	NITROGEN CHEM FERTILIZER	5	0	0	0	5
2911	GASOLINE, INCL NATURAL	0	4,155,632	0	541,166	4,696,798
2912	JET FUEL	0	955,840	0	115,868	1,071,708
2913	KEROSENE	0	113,680	0	38,921	152,601
2914	DISTILLATE FUEL OIL	0	4,793,813	0	825,123	5,618,936
2915	RESIDUAL FUEL OIL	0	3,773,673	0	728,784	4,502,457
2916	LUBRIC OILS-GREASES	0	93,222	0	14,283	107,505
2921	LIQUI PETR-COAL-NATR GAS	1,190	0	0	0	1,190
2922	Special VTS LNG Category	0	41,174	0	0	41,174
	Subzone Total :	2,966,387	13,992,230	9,954	2,270,164	19,238,735

Appendix A Zone 1 Boston, 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 105E CHELSEA AND MYSTIC RIVERS

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	257	0	0	0	257
3	FISHERIES PRODUCTS	39,051	0	0	0	39,051
4	MINING PRODUCTS, NEC	243,707	0	0	0	243,707
5	PROC. FOODS & MFTRS, NEC	1,162,489	0	3,918	0	1,166,407
6	WASTE OF MANUFACTURING	540,182	0	0	0	540,182
2811	CRUDE PROD-COAL TAR-PET	19	0	0	0	19
2817	BENZENE AND TOLUENE	0	1,549	0	0	1,549
2911	GASOLINE, INCL NATURAL	0	3,753,904	0	541,166	4,295,070
2912	JET FUEL	0	881,585	0	87,375	968,960
2913	KEROSENE	0	82,503	0	37,042	119,545
2914	DISTILLATE FUEL OIL	0	3,615,838	0	698,712	4,314,550
2915	RESIDUAL FUEL OIL	0	1,799,325	0	502,849	2,302,174
2916	LUBRIC OILS-GREASES	0	47,765	0	5,868	53,633
2922	Special VTS LNG Category	0	41,174	0	0	41,174
	Subzone Total :	1,985,705	10,223,643	3,918	1,873,012	14,086,278

7/22/91

Appendix A ZONE 1 Boston, MA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 101A				
Passenger	0	26	6,164	6,190
Dry Cargo	143	608	10,632	11,383
Tanker	269	345	307	921
Dry Cargo Barge Tow	88	0	95	183
Tanker Barge Tow	341	0	1,132	1,473
Tug/Tow Boat	0	0	1,872	1,872
Subzone Total:	841	979	20,202	22,022
Subzone : 102B				
Passenger	0	26	5,908	5,934
Dry Cargo	141	605	10,628	11,374
Tanker	237	286	236	759
Dry Cargo Barge Tow	88	0	95	183
Tanker Barge Tow	313	0	893	1,206
Tug/Tow Boat	0	0	1,643	1,643
Subzone Total:	779	917	19,403	21,099
Subzone : 103C				
Passenger	0	26	51,039	51,065
Dry Cargo	143	608	10,632	11,383
Tanker	269	345	306	920
Dry Cargo Barge Tow	88	0	95	183
Tanker Barge Tow	341	0	1,132	1,473
Tug/Tow Boat	0	0	1,872	1,872
Subzone Total:	841	979	65,076	66,896
Subzone : 104D				
Passenger	0	26	61,231	61,257
Dry Cargo	141	605	10,628	11,374
Tanker	237	286	236	759
Dry Cargo Barge Tow	88	0	95	183
Tanker Barge Tow	313	0	892	1,205
Tug/Tow Boat	0	0	1,639	1,639
Subzone Total:	779	917	74,721	76,417

Appendix A ZONE 1 Boston, MA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 105E				
Passenger	0	0	2,600	2,600
Dry Cargo	27	154	33	214
Tanker	157	203	209	569
Dry Cargo Barge Tow	88	0	91	179
Tanker Barge Tow	311	0	892	1,203
Tug/Tow Boat	0	0	1,269	1,269
Subzone Total:	583	357	5,094	6,034

Note: Sum of all vessel transits within each study subzone.

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ZONE TOTALS

ZONE 1 Boston, MA

Vessel Type	Large	Medium	Small	Total
Passenger	0	26	47,487	47,513
Dry Cargo	143	608	10,632	11,383
Tanker	269	345	307	921
Dry Cargo Barge Tow	88	0	95	183
Tanker Barge Tow	341	0	1,132	1,473
Tug/Tow Boat	0	0	1,872	1,872
Zone Total:	841	979	61,525	63,345

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix A

Zone 1 Boston, MA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/ departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix A Zone 1 Boston, MA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
101A	MASSACHUSETTS BAY	1,332	14.64
103C	BOSTON HARBOR	3,247	81.17
104D	BOSTON INNER HARBOR	1,731	752.61
105E	CHELSEA AND MYSTIC RIVERS	111	111.00
	Total for Zone	6,421	47.14

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

7/24/91

Appendix A ZONE 1 Boston, MA

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 101A				
Passenger	0	27	6,285	6,312
Dry Cargo	206	896	13,531	14,633
Tanker	271	375	305	951
Dry Cargo Tow	0	0	111	111
Tanker Tow	321	0	1,247	1,568
Tug/Tow Boat	0	0	2,177	2,177
Subzone Total:	798	1,298	23,656	25,752
Subzone : 102B				
Passenger	0	27	6,301	6,328
Dry Cargo	203	892	13,524	14,619
Tanker	239	312	234	785
Dry Cargo Tow	0	0	111	111
Tanker Tow	321	0	979	1,300
Tug/Tow Boat	0	0	1,893	1,893
Subzone Total:	763	1,231	23,042	25,036
Subzone : 103C				
Passenger	0	27	23,806	23,832
Dry Cargo	206	896	13,531	14,633
Tanker	271	375	304	950
Dry Cargo Tow	0	0	111	111
Tanker Tow	321	0	1,247	1,568
Tug/Tow Boat	0	0	2,177	2,177
Subzone Total:	798	1,298	41,176	43,271
Subzone : 104D				
Passenger	0	27	62,434	62,461
Dry Cargo	203	892	13,524	14,619
Tanker	239	312	234	785
Dry Cargo Tow	0	0	111	111
Tanker Tow	321	0	978	1,299
Tug/Tow Boat	0	0	1,889	1,889
Subzone Total:	763	1,231	79,170	81,164

Appendix A ZONE 1 Boston, MA 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 105E				
Passenger	0	0	2,651	2,651
Dry Cargo	40	196	42	278
Tanker	160	222	218	600
Dry Cargo Tow	0	0	96	96
Tanker Tow	251	0	978	1,229
Tug/Tow Boat	0	0	1,573	1,573
Subzone Total:	451	418	5,558	6,427

Note: Sum of all vessel transits within each study subzone.

Appendix A ZONE 1 Boston, MA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 101A				
Passenger	0	27	6,409	6,436
Dry Cargo	266	1,167	15,905	17,338
Tanker	281	399	309	989
Dry Cargo Tow	0	0	123	123
Tanker Tow	335	0	1,334	1,669
Tug/Tow Boat	0	0	2,433	2,433
Subzone Total:	882	1,593	26,513	28,988
Subzone : 102B				
Passenger	0	27	6,425	6,452
Dry Cargo	263	1,162	15,898	17,323
Tanker	248	332	237	817
Dry Cargo Tow	0	0	123	123
Tanker Tow	335	0	1,046	1,381
Tug/Tow Boat	0	0	2,128	2,128
Subzone Total:	846	1,521	25,857	28,224
Subzone : 103C				
Passenger	0	27	24,274	24,301
Dry Cargo	266	1,167	15,905	17,338
Tanker	281	399	308	988
Dry Cargo Tow	0	0	123	123
Tanker Tow	335	0	1,334	1,669
Tug/Tow Boat	0	0	2,433	2,433
Subzone Total:	882	1,593	44,377	46,852
Subzone : 104D				
Passenger	0	27	63,661	63,688
Dry Cargo	263	1,162	15,898	17,323
Tanker	248	332	237	817
Dry Cargo Tow	0	0	123	123
Tanker Tow	335	0	1,045	1,380
Tug/Tow Boat	0	0	2,124	2,124
Subzone Total:	846	1,521	83,088	85,455

Appendix A ZONE 1 Boston, MA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 105E				
Passenger	0	0	2,703	2,703
Dry Cargo	52	231	51	334
Tanker	166	237	228	631
Dry Cargo Tow	0	0	98	98
Tanker Tow	263	0	1,045	1,308
Tug/Tow Boat	0	0	1,745	1,745
Subzone Total:	481	468	5,870	6,819

Note: Sum of all vessel transits within each study subzone.

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Appendix A ZONE 1 Boston, MA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 101A				
Passenger	0	28	6,561	6,588
Dry Cargo	350	1,547	18,961	20,858
Tanker	291	423	317	1,031
Dry Cargo Tow	0	0	136	136
Tanker Tow	349	0	1,424	1,773
Tug/Tow Boat	0	0	2,751	2,751
Subzone Total:	990	1,998	30,150	33,137
Subzone : 102B				
Passenger	0	28	6,578	6,605
Dry Cargo	347	1,541	18,953	20,841
Tanker	257	353	242	852
Dry Cargo Tow	0	0	136	136
Tanker Tow	349	0	1,115	1,464
Tug/Tow Boat	0	0	2,425	2,425
Subzone Total:	953	1,922	29,449	32,323
Subzone : 103C				
Passenger	0	28	24,849	24,877
Dry Cargo	350	1,547	18,961	20,858
Tanker	291	423	316	1,030
Dry Cargo Tow	0	0	136	136
Tanker Tow	349	0	1,424	1,773
Tug/Tow Boat	0	0	2,751	2,751
Subzone Total:	990	1,998	48,437	51,425
Subzone : 104D				
Passenger	0	28	65,172	65,199
Dry Cargo	347	1,541	18,953	20,841
Tanker	257	353	242	852
Dry Cargo Tow	0	0	136	136
Tanker Tow	349	0	1,114	1,463
Tug/Tow Boat	0	0	2,421	2,421
Subzone Total:	953	1,922	88,038	90,912

Appendix A ZONE 1 Boston, MA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 105E				
Passenger	0	0	2,767	2,767
Dry Cargo	70	278	62	410
Tanker	172	252	238	662
Dry Cargo Tow	0	0	101	101
Tanker Tow	274	0	1,114	1,388
Tug/Tow Boat	0	0	1,961	1,961
Subzone Total:	516	530	6,243	7,289

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix A ZONE 1 Boston, MA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 101A				
Passenger	0	28	6,716	6,745
Dry Cargo	467	2,083	22,937	25,487
Tanker	301	450	325	1,076
Dry Cargo Tow	0	0	150	150
Tanker Tow	364	0	1,520	1,884
Tug/Tow Boat	0	0	3,165	3,165
Subzone Total:	1,132	2,561	34,813	38,507
Subzone : 102B				
Passenger	0	28	6,734	6,762
Dry Cargo	463	2,076	22,928	25,467
Tanker	266	376	248	890
Dry Cargo Tow	0	0	150	150
Tanker Tow	364	0	1,189	1,553
Tug/Tow Boat	0	0	2,816	2,816
Subzone Total:	1,093	2,480	34,065	37,638
Subzone : 103C				
Passenger	0	28	25,439	25,467
Dry Cargo	467	2,083	22,937	25,487
Tanker	301	450	324	1,075
Dry Cargo Tow	0	0	150	150
Tanker Tow	364	0	1,520	1,884
Tug/Tow Boat	0	0	3,165	3,165
Subzone Total:	1,132	2,561	53,535	57,228
Subzone : 104D				
Passenger	0	28	66,718	66,746
Dry Cargo	463	2,076	22,928	25,467
Tanker	266	376	248	890
Dry Cargo Tow	0	0	150	150
Tanker Tow	364	0	1,188	1,552
Tug/Tow Boat	0	0	2,811	2,811
Subzone Total:	1,093	2,480	94,043	97,616

Appendix A ZONE 1 Boston, MA 7/24/91

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 105E				
Passenger	0	0	2,833	2,833
Dry Cargo	95	341	76	512
Tanker	179	268	248	695
Dry Cargo Tow	0	0	104	104
Tanker Tow	287	0	1,188	1,475
Tug/Tow Boat	0	0	2,238	2,238
Subzone Total:	561	609	6,687	7,857

Note: Sum of all vessel transits within each study subzone.

Appendix A ZONE 1 Boston, MA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	27	48,420	48,447
Dry Cargo	190	827	12,498	13,515
Tanker	271	375	305	951
Dry Cargo Tow	0	0	5,111	5,111
Tanker Tow	321	0	1,247	1,568
Tug/Tow Boat	0	0	2,177	2,177
1995 Zone Total:	782	1,229	69,758	71,769
2000 FORECASTED ZONE TOTALS				
Passenger	0	27	49,372	49,399
Dry Cargo	234	1,026	13,998	15,258
Tanker	281	399	309	989
Dry Cargo Tow	0	0	5,123	5,123
Tanker Tow	335	0	1,334	1,669
Tug/Tow Boat	0	0	2,433	2,433
2000 Zone Total:	850	1,452	72,569	74,871
2005 FORECASTED ZONE TOTALS				
Passenger	0	28	50,543	50,571
Dry Cargo	308	1,326	16,273	17,907
Tanker	291	423	317	1,031
Dry Cargo Tow	0	0	5,136	5,136
Tanker Tow	349	0	1,424	1,773
Tug/Tow Boat	0	0	2,751	2,751
2005 Zone Total:	948	1,777	76,444	79,169
2010 FORECASTED ZONE TOTALS				
Passenger	0	28	51,742	51,770
Dry Cargo	410	1,785	19,685	21,880
Tanker	301	450	325	1,076
Dry Cargo Tow	0	0	5,150	5,150
Tanker Tow	364	0	1,520	1,884
Tug/Tow Boat	0	0	3,165	3,165
2010 Zone Total:	1,075	2,263	81,587	84,925

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix A Zone 1 Boston, MA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 101A MASSACHUSETTS BAY						
Tanker	Large	0	0	1	0	1
Tanker	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	2	0	2
Fishing	Small	0	0	2	0	2
Subzone Totals:		0	0	6	0	6
Subzone: 102B CONVERGENCE AREA						
Passenger	Small	0	0	1	0	1
Dry Cargo	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	0	3	0	3
Subzone: 103C BOSTON HARBOR						
Passenger	Small	1	0	1	0	2
Tanker	Large	0	1	1	0	2
Tanker Barge Tow	Small	0	0	3	0	3
Tug/Tow Boat	Small	0	1	0	0	1
Fishing	Small	1	0	3	0	4
Other	Small	0	1	0	0	1
Subzone Totals:		2	3	8	0	13
Subzone: 104D BOSTON INNER HARBOR						
Dry Cargo	Large	0	1	0	0	1
Other	Small	0	1	0	0	1
Subzone Totals:		0	2	0	0	2
Subzone: 105E CHELSEA AND MYSTIC RIVERS						
Tanker	Large	0	2	0	0	2
Tanker Barge Tow	Large	0	0	1	0	1
Tanker Barge Tow	Small	0	1	0	0	1
Tug/Tow Boat	Small	0	1	0	0	1
Subzone Totals:		0	4	1	0	5
Zone Totals:		2	9	18	0	29

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE A-8 ZONE 1, BOSTON, MA - VTS LEVELS IN OPERATION

(Not Applicable to this Sub-Zone.)

APPENDIX TABLE A-9 ZONE 1, BOSTON, MA - CANDIDATE VTS DESIGN - 1995-2010

UNITS		
2	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
2	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
2	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via Microwave

Appendix A Zone 1 Boston, MA

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.03	0.00	.04	.07
Passenger	Small	1.16	.18	1.34	2.69
Dry Cargo	Large	.18	.03	.26	.46
Dry Cargo	Medium	.30	.05	.14	.50
Dry Cargo	Small	.97	.12	.22	1.31
Tanker	Large	.52	.12	.77	1.41
Tanker	Medium	.09	.01	.06	.16
Tanker	Small	.03	0.00	.03	.06
Dry Cargo Barge T	Small	1.67	.55	.86	3.08
Tanker Barge Tow	Large	.22	.10	.15	.47
Tanker Barge Tow	Small	1.11	.20	.77	2.08
Tug/Tow Boat	Small	.13	.05	.12	.30
		6.42	1.42	4.75	12.59

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	48	0	43	91
Passenger	Small	1,004	152	832	1,988
Dry Cargo	Large	243	55	81	379
Dry Cargo	Medium	452	96	43	591
Dry Cargo	Small	654	80	133	867
Tanker	Large	28,463	6,060	6,014	40,537
Tanker	Medium	165	18	44	227
Tanker	Small	23	0	7	30
Dry Cargo Barge T	Small	91	53	14	158
Tanker Barge Tow	Large	2,703	1,262	1,168	5,133
Tanker Barge Tow	Small	3,195	581	254	4,030
Tug/Tow Boat	Small	10	6	8	24
		37,052	8,363	8,640	54,055

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.01
Passenger	Small	.07	.01	.09	.17
Dry Cargo	Large	.02	.00	.03	.06
Dry Cargo	Medium	.04	.01	.02	.06
Dry Cargo	Small	.06	.01	.01	.08
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.21	.03	.16	.40
Candidate VTS Design - Dollars					
Passenger	Medium	5,110.78	0.00	7,227.06	12,337.84
Passenger	Small	111,373.78	17,625.38	129,045.34	258,044.50
Dry Cargo	Large	33,209.70	5,936.66	48,320.50	87,466.86
Dry Cargo	Medium	57,186.96	9,698.95	26,828.83	93,714.74
Dry Cargo	Small	92,792.52	11,564.63	21,096.62	125,453.77
Tanker	Small	115.60	0.00	93.20	208.80
Dry Cargo Barge Tow	Small	5,519.21	1,824.69	2,846.13	10,190.03
Tanker Barge Tow	Small	3,683.33	652.86	2,531.98	6,868.18
Tug/Tow Boat	Small	441.98	160.41	392.42	994.82
Totals		309,433.86	47,463.58	238,382.09	595,279.53

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.88	.14	1.02	2.04
Dry Cargo	Large	.00	.00	.00	.01
Dry Cargo	Medium	.00	.00	.00	.01
Dry Cargo	Small	.73	.09	.17	.99
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.04	.01	.02	.07
Tanker Barge Tow	Small	.03	.00	.02	.05
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		1.69	.25	1.24	3.18
Candidate VTS Design - Dollars					
Passenger	Medium	87.75	0.00	124.09	211.84
Passenger	Small	209,718.67	33,188.87	242,994.52	485,902.07
Dry Cargo	Large	570.20	101.93	829.65	1,501.78
Dry Cargo	Medium	981.89	166.53	460.64	1,609.06
Dry Cargo	Small	174,729.86	21,776.38	39,725.28	236,231.52
Tanker	Small	201.99	0.00	162.85	364.83
Dry Cargo Barge Tow	Small	9,643.79	3,188.31	4,973.08	17,805.19
Tanker Barge Tow	Small	6,435.94	1,140.75	4,424.17	12,000.87
Tug/Tow Boat	Small	772.28	280.29	685.69	1,738.26
Totals		403,142.38	59,843.07	294,379.97	757,365.42

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.02	0.00	.02	.04
Passenger	Small	.99	.12	.42	1.53
Dry Cargo	Large	.13	.02	.03	.18
Dry Cargo	Medium	.23	.04	.01	.28
Dry Cargo	Small	.83	.08	.11	1.03
Tanker	Large	.39	.10	.10	.59
Tanker	Medium	.07	.01	.01	.09
Tanker	Small	.01	0.00	.01	.01
Dry Cargo Barge Tow	Small	1.27	.23	.12	1.63
Tanker Barge Tow	Large	.20	.05	.03	.28
Tanker Barge Tow	Small	.85	.08	.11	1.04
Tug/Tow Boat	Small	.02	.01	.01	.04
Totals		5.01	.74	.98	6.74
Candidate VTS Design - Dollars					
Passenger	Medium	17,582.36	0.00	14,436.43	32,018.79
Passenger	Small	336,948.07	41,678.38	216,324.00	594,950.45
Dry Cargo	Large	96,525.92	16,513.21	14,880.26	127,919.40
Dry Cargo	Medium	200,807.83	32,592.57	6,177.02	239,577.42
Dry Cargo	Small	157,208.34	15,931.50	29,545.57	202,685.40
Tanker	Large	310,496.61	76,551.60	216,834.25	603,882.46
Tanker	Medium	46,686.18	4,668.52	14,331.40	65,686.11
Tanker	Small	2,290.99	0.00	2,409.17	4,700.15
Dry Cargo Barge Tow	Small	73,971.27	13,541.52	6,090.47	93,603.26
Tanker Barge Tow	Large	32,530.95	8,285.59	5,894.83	46,711.37
Tanker Barge Tow	Small	60,311.06	5,919.28	9,625.90	75,856.25
Tug/Tow Boat	Small	1,686.40	393.12	1,455.96	3,535.48
Totals		1,337,045.98	216,075.29	538,005.27	2,091,126.54

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.00	.01
Passenger	Small	.26	.03	.12	.41
Dry Cargo	Large	.05	.01	.03	.10
Dry Cargo	Medium	.09	.02	.02	.13
Dry Cargo	Small	.38	.04	.05	.47
Tanker	Large	.16	.04	.10	.30
Tanker	Medium	.03	.00	.01	.04
Tanker	Small	.01	0.00	.00	.01
Dry Cargo Tow	Small	.35	.12	.07	.54
Tanker Tow	Large	.03	.01	.02	.05
Tanker Tow	Small	.24	.04	.07	.34
Tug/Tow Boat	Small	.01	.00	.00	.02
Totals		1.61	.32	.50	2.43
Candidate VTS Design - Dollars					
Passenger	Medium	77.35	0.00	44.93	122.28
Passenger	Small	852.12	105.40	488.54	1,446.05
Dry Cargo	Large	496.97	125.87	68.38	691.21
Dry Cargo	Medium	855.77	205.63	37.97	1,099.37
Dry Cargo	Small	713.45	72.30	132.63	918.38
Tanker	Large	8,788.74	2,085.36	10,811.39	21,685.50
Tanker	Medium	378.93	37.26	90.72	506.91
Tanker	Small	35.79	0.00	16.01	51.80
Tanker Tow	Large	11,434.69	3,072.67	4,254.72	18,762.07
Tanker Tow	Small	14,152.98	2,601.09	4,224.53	20,978.60
Tug/Tow Boat	Small	20.30	4.73	17.06	42.09
Totals		37,807.09	8,310.29	20,186.88	66,304.27

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.02	.01	.03
Dry Cargo	Large	0.00	.00	.00	.01
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.01	.00	.02
Tanker	Large	0.00	.01	.00	.02
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.06	.00	.07
Tanker Barge Tow	Large	0.00	.01	.00	.01
Tanker Barge Tow	Small	0.00	.02	.00	.03
Tug/Tow Boat	Small	0.00	.01	.00	.01
Totals		0.00	.16	.03	.19
Candidate VTS Design - Dollars					
Passenger	Small	0.00	118.50	43.43	161.93
Dry Cargo	Large	0.00	20.37	8.30	28.67
Dry Cargo	Medium	0.00	33.28	4.61	37.89
Dry Cargo	Small	0.00	77.75	7.10	84.85
Tanker	Large	0.00	78.59	24.82	103.41
Tanker	Medium	0.00	5.69	1.97	7.66
Tanker	Small	0.00	0.00	.91	.91
Dry Cargo Barge Tow	Small	0.00	356.34	27.82	384.16
Tanker Barge Tow	Large	0.00	65.66	4.77	70.43
Tanker Barge Tow	Small	0.00	127.49	24.75	152.25
Tug/Tow Boat	Small	0.00	31.33	3.84	35.16
Totals		0.00	915.00	152.33	1,067.32

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.01	0.00	.01
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.02	0.00	.02
Tanker Barge Tow	Large	0.00	.01	0.00	.01
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.07	0.00	.07
Candidate VTS Design - Dollars					
Passenger	Small	1,875.69	14,158.84	0.00	16,034.54
Dry Cargo	Large	0.00	4,493.17	0.00	4,493.17
Dry Cargo	Medium	0.00	7,279.65	0.00	7,279.65
Dry Cargo	Small	1,225.55	7,243.24	0.00	8,468.79
Tanker	Large	0.00	21,087.44	0.00	21,087.44
Tanker	Medium	0.00	1,539.41	0.00	1,539.41
Tanker	Small	77.23	0.00	0.00	77.23
Dry Cargo Barge Tow	Small	2,188.64	34,080.03	0.00	36,268.67
Tanker Barge Tow	Large	0.00	18,181.53	0.00	18,181.53
Tanker Barge Tow	Small	2,474.09	19,506.55	0.00	21,980.64
Tug/Tow Boat	Small	216.54	3,574.43	0.00	3,790.97
Totals		8,057.75	131,144.28	0.00	139,202.03

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix A Zone 1 Boston, MA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
BENZENE AND TOLUENE	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.01	.00	.01
JET FUEL	.00	.01	.02	.00	.03
RESIDUAL FUEL OIL	.01	.04	.20	.22	.46
GASOLINE, INCL NATURAL	.01	.05	.09	.01	.16
DISTILLATE FUEL OIL	.02	.05	.14	.59	.81
	.04	.15	.46	.82	1.48

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix A Zone 1 Boston, MA
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,988	0	0
1996	0	360	2,559
1997	0	327	2,361
1998	0	297	2,178
1999	0	270	2,008
2000	0	246	1,851
2001	0	223	1,708
2002	0	203	1,576
2003	0	185	1,453
2004	0	168	1,340
2005	0	153	1,235
2006	0	139	1,141
2007	0	126	1,051
2008	0	115	969
2009	0	104	894
2010	0	95	824
	4,988	3,011	23,149

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,988	0	0
1996	0	457	3,252
1997	0	457	3,300
1998	0	457	3,349
1999	0	457	3,396
2000	0	457	3,444
2001	0	457	3,495
2002	0	457	3,547
2003	0	457	3,598
2004	0	457	3,649
2005	0	457	3,699
2006	0	457	3,758
2007	0	457	3,809
2008	0	457	3,864
2009	0	457	3,919
2010	0	457	3,974
	4,988	6,858	54,055

APPENDIX A

ZONE 1 - BOSTON, MA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Boston Harbor Port & Subzone	Species Category	(Port 1) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0101	101	1	American Shad	.1200	.5800	0.0000	.0580
0101	101	2	Alewife	2.0864	0.0000	0.0000	0.0000
0101	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0101	102	3	Atl.Menhaden	0.0000	2.9638	2.9638	2.9638
0101	102	4	Atl.Herring	2.1219	2.1219	2.1219	0.0000
0101	102	6	Pollock	.2952	.2952	.2952	.2952
0101	102	7	Atl.Mackerel	.3853	.3853	.3853	.3853
0101	103	8	Bluefish	.2700	.3200	.3200	0.0000
0101	103	9	Striped Bass	.2600	.4700	.4200	.4200
0101	103	10	Monkfish	.0278	.0278	.0278	.0278
0101	103	11	Weakfish	.3100	.3100	.3100	.0070
0101	104	12	Tuna	0.0000	.1911	0.0000	0.0000
0101	105	16	Yellowtail Flounder	.3066	.3066	.3066	.3066
0101	105	17	Summer Flounder	.0140	.0140	.0140	.0140
0101	105	18	Amer.Plaice	.1387	.1387	.1387	.1387
0101	105	19	Witch Flounder	.1245	.1245	.1245	.1245
0101	105	20	Winter Flounder	.1359	0.0000	.2717	.2717
0101	106	21	Atl.Cod	.8591	.8591	.8591	.8591
0101	106	22	Haddock	.4387	.4387	.4387	.4387
0101	106	23	Redfish	.0804	.0804	.0804	.0804
0101	106	24	Silver Hake	0.0000	1.5364	1.5364	1.5364
0101	106	25	Red Hake	.0583	.0583	.0583	.0583
0101	106	26	White Hake	.0750	.0750	.0750	.0750
0101	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0101	106	35	Croaker	.3700	.3700	.3700	0.0000
0101	106	36	Drum	.0020	.0020	.0020	0.0000
0101	106	37	Spot	.0960	.0490	0.0000	.0490
0101	106	39	Carp	.0250	.0250	.0250	.0250
0101	106	66	Cusk	.0700	.0700	.0700	.0700
0101	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
0101	106	199	Other	.7800	.7800	.7800	.7800
0101	107	203	Sea Scallops	.1626	.1626	.1626	.1626
0101	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
0101	107	214	Conch	.0660	.0660	.0660	.0660
0101	108	204	Lobster	1.2984	1.2984	1.2984	1.2984
0101	108	205	Northern Shrimp	.0548	.0548	.0548	.0548
0101	109	207	Squid	.0861	.0861	0.0000	0.0000
0102	101	1	American Shad	.1200	.5800	0.0000	.0580
0102	101	2	Alewife	2.0864	0.0000	0.0000	0.0000
0102	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0102	102	3	Atl.Menhaden	0.0000	2.9638	2.9638	2.9638
0102	102	4	Atl.Herring	2.1219	2.1219	2.1219	0.0000
0102	102	6	Pollock	.2952	.2952	.2952	.2952
0102	102	7	Atl.Mackerel	.3853	.3853	.3853	.3853
0102	103	8	Bluefish	.2700	.3200	.3200	0.0000
0102	103	9	Striped Bass	.2600	.4700	.4200	.4200
0102	103	10	Monkfish	.0278	.0278	.0278	.0278
0102	103	11	Weakfish	.3100	.3100	.3100	.0070
0102	104	12	Tuna	0.0000	.1911	0.0000	0.0000
0102	105	16	Yellowtail Flounder	.3066	.3066	.3066	.3066
0102	105	17	Summer Flounder	.0140	.0140	.0140	.0140
0102	105	18	Amer.Plaice	.1387	.1387	.1387	.1387
0102	105	19	Witch Flounder	.1245	.1245	.1245	.1245
0102	105	20	Winter Flounder	.1359	0.0000	.2717	.2717

APPENDIX A

ZONE 1 - BOSTON, MA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Boston Harbor (Port 1)

Wildlife Abundance Tables, Fish & Shellfish, Grams per Square Meter

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0102	106	21	Atl.Cod	.8591	.8591	.8591	.8591
0102	106	22	Haddock	.4387	.4387	.4387	.4387
0102	106	23	Redfish	.0804	.0804	.0804	.0804
0102	106	24	Silver Hake	0.0000	1.5364	1.5364	1.5364
0102	106	25	Red Hake	.0583	.0583	.0583	.0583
0102	106	26	White Hake	.0750	.0750	.0750	.0750
0102	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0102	106	35	Croaker	.3700	.3700	.3700	0.0000
0102	106	36	Drum	.0020	.0020	.0020	0.0000
0102	106	37	Spot	.0960	.0490	0.0000	.0490
0102	106	39	Carp	.0250	.0250	.0250	.0250
0102	106	66	Cusk	.0700	.0700	.0700	.0700
0102	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
0102	106	199	Other	.7800	.7800	.7800	.7800
0102	107	37	Surf Clam	.0124	.0124	.0124	.0124
0102	107	208	Blue Mussel	.0563	.0563	.0563	.0563
0102	107	208	Blue Mussel	.0563	.0563	.0563	.0563
0102	107	208	Blue Mussel	.0563	.0563	.0563	.0563
0102	107	208	Blue Mussel	.0563	.0563	.0563	.0563
0102	107	211	Soft Clam	.2431	.2431	.2431	.2431
0102	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
0102	107	213	Hard Clam	.2830	.2830	.2830	.2830
0102	107	214	Conch	.0660	.0660	.0660	.0660
0102	108	204	Lobster	1.2984	1.2984	1.2984	1.2984
0102	108	205	Northern Shrimp	.0548	.0548	.0548	.0548
0102	109	207	Squid	.0861	.0861	0.0000	0.0000
0103	101	1	American Shad	.1200	.5800	0.0000	.0580
0103	101	2	Alewife	2.0864	0.0000	0.0000	0.0000
0103	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0103	102	3	Atl.Menhaden	0.0000	2.9638	2.9638	2.9638
0103	102	4	Atl.Herring	2.1219	2.1219	2.1219	0.0000
0103	102	6	Pollock	.2952	.2952	.2952	.2952
0103	102	7	Atl.Mackerel	.3853	.3853	.3853	.3853
0103	103	8	Bluefish	.2700	.3200	.3200	0.0000
0103	103	9	Striped Bass	.2600	.4700	.4200	.4200
0103	103	10	Monkfish	.0278	.0278	.0278	.0278
0103	103	11	Weakfish	.3100	.3100	.3100	.0070
0103	104	12	Tuna	0.0000	.1911	0.0000	0.0000
0103	105	16	Yellowtail Flounder	.3066	.3066	.3066	.3066
0103	105	17	Summer Flounder	.0140	.0140	.0140	.0140
0103	105	18	Amer.Plaice	.1387	.1387	.1387	.1387
0103	105	19	Witch Flounder	.1245	.1245	.1245	.1245
0103	105	20	Winter Flounder	.1359	0.0000	.2717	.2717
0103	106	21	Atl.Cod	.8591	.8591	.8591	.8591
0103	106	22	Haddock	.4387	.4387	.4387	.4387
0103	106	23	Redfish	.0804	.0804	.0804	.0804
0103	106	24	Silver Hake	0.0000	1.5364	1.5364	1.5364
0103	106	25	Red Hake	.0583	.0583	.0583	.0583
0103	106	26	White Hake	.0750	.0750	.0750	.0750
0103	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0103	106	35	Croaker	.3700	.3700	.3700	0.0000
0103	106	36	Drum	.0020	.0020	.0020	0.0000
0103	106	37	Spot	.0960	.0490	0.0000	.0490
0103	106	39	Carp	.0250	.0250	.0250	.0250
0103	106	66	Cusk	.0700	.0700	.0700	.0700

APPENDIX A

ZONE 1 - BOSTON, MA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Boston Harbor Port & Subzone	Species Category	(Port 1) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0103	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
0103	106	199	Other	.7800	.7800	.7800	.7800
0103	107	37	Surf Clam	.0124	.0124	.0124	.0124
0103	107	211	Soft Clam	.2431	.2431	.2431	.2431
0103	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
0103	107	213	Hard Clam	.2830	.2830	.2830	.2830
0103	107	214	Conch	.0660	.0660	.0660	.0660
0103	108	204	Lobster	1.2984	1.2984	1.2984	1.2984
0103	108	205	Northern Shrimp	.0548	.0548	.0548	.0548
0103	109	207	Squid	.0861	.0861	0.0000	0.0000
0104	101	1	American Shad	.1200	.5800	0.0000	.0580
0104	101	2	Alewife	2.0864	0.0000	0.0000	0.0000
0104	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0104	102	3	Atl.Menhaden	0.0000	2.9638	2.9638	2.9638
0104	102	4	Atl.Herring	2.1219	2.1219	2.1219	0.0000
0104	102	6	Pollock	.2952	.2952	.2952	.2952
0104	102	7	Atl.Mackerel	.3853	.3853	.3853	.3853
0104	103	8	Bluefish	.2700	.3200	.3200	0.0000
0104	103	9	Striped Bass	.2600	.4700	.4200	.4200
0104	103	10	Monkfish	.0278	.0278	.0278	.0278
0104	103	11	Weakfish	.3100	.3100	.3100	.0070
0104	104	12	Tuna	0.0000	.1911	0.0000	0.0000
0104	105	16	Yellowtail Flounder	.3066	.3066	.3066	.3066
0104	105	17	Summer Flounder	.0140	.0140	.0140	.0140
0104	105	18	Amer.Plaice	.1387	.1387	.1387	.1387
0104	105	19	Witch Flounder	.1245	.1245	.1245	.1245
0104	105	20	Winter Flounder	.1359	0.0000	.2717	.2717
0104	106	21	Atl.Cod	.8591	.8591	.8591	.8591
0104	106	22	Haddock	.4387	.4387	.4387	.4387
0104	106	23	Redfish	.0804	.0804	.0804	.0804
0104	106	24	Silver Hake	0.0000	1.5364	1.5364	1.5364
0104	106	25	Red Hake	.0583	.0583	.0583	.0583
0104	106	26	White Hake	.0750	.0750	.0750	.0750
0104	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0104	106	35	Croaker	.3700	.3700	.3700	0.0000
0104	106	36	Drum	.0020	.0020	.0020	0.0000
0104	106	37	Spot	.0960	.0490	0.0000	.0490
0104	106	39	Carp	.0250	.0250	.0250	.0250
0104	106	66	Cusk	.0700	.0700	.0700	.0700
0104	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
0104	106	199	Other	.7800	.7800	.7800	.7800
0104	107	37	Surf Clam	.0124	.0124	.0124	.0124
0104	107	211	Soft Clam	.2431	.2431	.2431	.2431
0104	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
0104	107	213	Hard Clam	.2830	.2830	.2830	.2830
0104	107	214	Conch	.0660	.0660	.0660	.0660
0104	108	204	Lobster	1.2984	1.2984	1.2984	1.2984
0104	108	205	Northern Shrimp	.0548	.0548	.0548	.0548
0105	101	1	American Shad	.1200	.5800	0.0000	.0580
0105	101	2	Alewife	2.0864	0.0000	0.0000	0.0000
0105	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0105	102	3	Atl.Menhaden	0.0000	2.9638	2.9638	2.9638
0105	102	4	Atl.Herring	2.1219	2.1219	2.1219	0.0000
0105	102	6	Pollock	.2952	.2952	.2952	.2952
0105	102	7	Atl.Mackerel	.3853	.3853	.3853	.3853

APPENDIX A

ZONE 1 - BOSTON, MA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Boston Harbor		(Port 1)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0105	103	8	Bluefish	.2700	.3200	.3200	0.0000
0105	103	9	Striped Bass	.2600	.4700	.4200	.4200
0105	103	10	Monkfish	.0278	.0278	.0278	.0278
0105	103	11	Weakfish	.3100	.3100	.3100	.0070
0105	104	12	Tuna	0.0000	.1911	0.0000	0.0000
0105	105	16	Yellowtail Flounder	.3066	.3066	.3066	.3066
0105	105	17	Summer Flounder	.0140	.0140	.0140	.0140
0105	105	18	Amer.Plaice	.1387	.1387	.1387	.1387
0105	105	19	Witch Flounder	.1245	.1245	.1245	.1245
0105	105	20	Winter Flounder	.1359	0.0000	.2717	.2717
0105	106	21	Atl.Cod	.8591	.8591	.8591	.8591
0105	106	22	Haddock	.4387	.4387	.4387	.4387
0105	106	23	Redfish	.0804	.0804	.0804	.0804
0105	106	24	Silver Hake	0.0000	1.5364	1.5364	1.5364
0105	106	25	Red Hake	.0583	.0583	.0583	.0583
0105	106	26	White Hake	.0750	.0750	.0750	.0750
0105	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0105	106	35	Croaker	.3700	.3700	.3700	0.0000
0105	106	36	Drum	.0020	.0020	.0020	0.0000
0105	106	37	Spot	.0960	.0490	0.0000	.0490
0105	106	39	Carp	.0250	.0250	.0250	.0250
0105	106	66	Cusk	.0700	.0700	.0700	.0700
0105	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
0105	106	199	Other	.7800	.7800	.7800	.7800
0105	107	37	Surf Clam	.0124	.0124	.0124	.0124
0105	107	211	Soft Clam	.2431	.2431	.2431	.2431
0105	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
0105	107	213	Hard Clam	.2830	.2830	.2830	.2830
0105	107	214	Conch	.0660	.0660	.0660	.0660
0105	108	204	Lobster	1.2984	1.2984	1.2984	1.2984
0105	108	205	Northern Shrimp	.0548	.0548	.0548	.0548

APPENDIX A

ZONE 1 - BOSTON, MA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Boston Harbor		(Port 1)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0101	202		Larvae	.1900	.8100	.8100	.2200
0101	203		Larvae	.0110	.1700	.0054	0.0000
0101	204	1002	Herring	.3000	0.0000	0.0000	0.0000
0101	205	1018	Amer. Plaice	.2750	0.0000	0.0000	0.0000
0101	205	1020	Winter Flounder	.4750	0.0000	0.0000	0.0000
0101	205	1114	Gunnel	.9000	0.0000	0.0000	0.0000
0101	206	1109	Sculpin	6.2250	0.0000	0.0000	0.0000
0101	206	1110	Sand Lance	1.0750	0.0000	0.0000	0.0000
0101	206	1111	Alligator Fish	.0750	0.0000	0.0000	0.0000
0101	206	1112	Lumpfish	.1500	0.0000	0.0000	0.0000
0101	206	1112	Sea Snail	2.1000	0.0000	0.0000	0.0000
0101	206	1199	Shanny	8.1000	0.0000	0.0000	0.0000
0101	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
0101	208	1199	Larvae	.0016	.0042	0.0000	0.0000
0102	202		Larvae	.1900	.8100	.8100	.2200
0102	203		Larvae	.0110	.1700	.0054	0.0000
0102	204	1002	Herring	.3000	0.0000	0.0000	0.0000
0102	205	1018	Amer. Plaice	.2750	0.0000	0.0000	0.0000
0102	205	1020	Winter Flounder	.4750	0.0000	0.0000	0.0000
0102	205	1114	Gunnel	.9000	0.0000	0.0000	0.0000
0102	206	1109	Sculpin	6.2250	0.0000	0.0000	0.0000
0102	206	1110	Sand Lance	1.0750	0.0000	0.0000	0.0000
0102	206	1111	Alligator Fish	.0750	0.0000	0.0000	0.0000
0102	206	1112	Lumpfish	.1500	0.0000	0.0000	0.0000
0102	206	1112	Sea Snail	2.1000	0.0000	0.0000	0.0000
0102	206	1199	Shanny	8.1000	0.0000	0.0000	0.0000
0102	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
0102	208	1199	Larvae	.0016	.0042	0.0000	0.0000
0103	202		Larvae	.1900	.8100	.8100	.2200
0103	203		Larvae	.0110	.1700	.0054	0.0000
0103	205	1018	American Plaice	.2250	0.0000	0.0000	0.0000
0103	205	1020	Winter Flounder	.5000	0.0000	0.0000	0.0000
0103	206	1021	Atlantic Cod	.0750	0.0000	0.0000	0.0000
0103	206	1021	Sand Lance	.3750	0.0000	0.0000	0.0000
0103	206	1021	Sculpin	2.5500	0.0000	0.0000	0.0000
0103	206	1021	Sea Snail	.0750	0.0000	0.0000	0.0000
0103	206	1021	Shanny	1.3750	0.0000	0.0000	0.0000
0103	206	1021	Tomcod	.0750	0.0000	0.0000	0.0000
0103	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
0103	208	1199	Larvae	.0016	.0042	0.0000	0.0000
0104	202		Larvae	12.4000	52.7000	53.4000	14.3000
0104	203		Larvae	.0640	1.1000	.0310	0.0000
0104	205		Larvae	10.9000	6.5000	3.6000	.0400
0104	206	1199	Larvae	.2100	3.6000	8.0000	.1500
0104	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
0104	208	1199	Larvae	.0160	.0042	0.0000	0.0000
0105	202		Larvae	12.4000	52.7000	53.4000	14.3000
0105	203		Larvae	.0640	1.1000	.0310	0.0000
0105	205		Larvae	10.9000	6.5000	3.6000	.0400
0105	206	1199	Larvae	.2100	3.6000	8.0000	.1500
0105	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
0105	208	1199	Larvae	.0016	.0042	0.0000	0.0000

APPENDIX A

ZONE 1 - BOSTON, MA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

Boston Harbor Port & Subzone	Species Category	(Port 1) Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0101	111	511	Dabbling Ducks	.0104	0.0000	0.0000	.3615
0101	111	513	Geese	.5209	0.0000	0.0000	0.0000
0101	111	515	Diving Ducks	1.1565	0.0000	0.0000	9.3613
0101	111	516	Loons	.0104	.0052	0.0000	.0021
0101	111	517	Grebes	0.0000	0.0000	0.0000	.0729
0101	112	571	Sandpiper,Plover,Turnstone	.0002	0.0000	0.0000	.0354
0101	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
0101	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
0101	113	531	Gulls	10.9398	13.5445	0.0000	.0156
0101	114	583	Hawks	0.0000	0.0000	0.0000	.0010
0101	114	584	Owls	0.0000	0.0000	0.0000	.0010
0102	111	511	Dabbling Ducks	.4950	0.0000	0.0000	0.0000
0102	111	515	Diving Ducks	1.9802	0.0000	0.0000	0.0000
0102	113	530	Cormorant	4.9505	0.0000	0.0000	0.0000
0102	113	531	Gulls	12.3762	0.0000	0.0000	0.0000
0103	111	511	Dabbling Ducks	.0471	0.0000	0.0000	4.3467
0103	111	513	Geese	0.0000	0.0000	0.0000	.3204
0103	111	514	Swans	0.0000	0.0000	0.0000	.0157
0103	111	515	Diving Ducks	.2513	0.0000	0.0000	22.5534
0103	111	516	Loons	0.0000	0.0000	0.0000	.0063
0103	111	517	Grebes	0.0000	0.0000	0.0000	.0126
0103	112	571	Sandpiper,Plover,Turnstone	.0251	0.0000	0.0000	0.0000
0103	112	572	Oystercatcher,Avocet,Stilt	.0126	.0314	0.0000	0.0000
0103	113	530	Cormorant	.0377	0.0000	0.0000	0.0000
0103	113	531	Gulls	6.2814	0.0000	0.0000	.0126
0103	113	537	Storm Petrels	0.0000	25.0000	0.0000	0.0000
0103	114	583	Hawks	0.0000	0.0000	0.0000	10.0000
0103	114	584	Owls	0.0000	0.0000	0.0000	3.0000
0104	111	511	Dabbling Ducks	.2591	0.0000	0.0000	8.5492
0104	111	513	Geese	0.0000	0.0000	0.0000	14.9741
0104	111	515	Diving Ducks	.5181	0.0000	0.0000	98.0829
0104	113	531	Gulls	25.9067	0.0000	0.0000	0.0000
0104	114	584	Owls	0.0000	0.0000	0.0000	.1036
0105	111	511	Dabbling Ducks	.7813	0.0000	0.0000	0.0000
0105	111	515	Diving Ducks	1.5625	0.0000	0.0000	0.0000
0105	113	531	Gulls	31.2500	0.0000	0.0000	0.0000

APPENDIX B

PUGET SOUND, WA

(ZONE 2)

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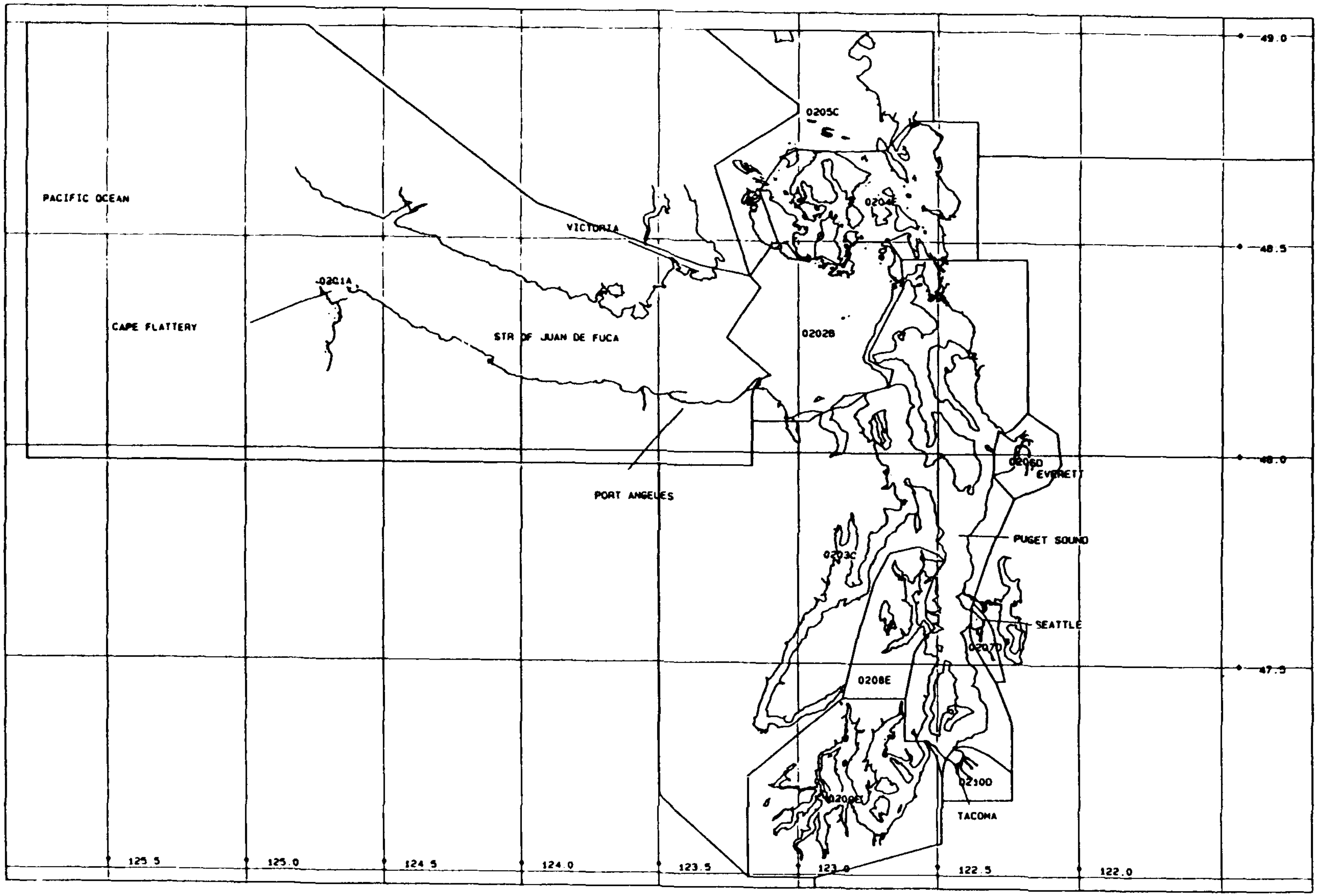
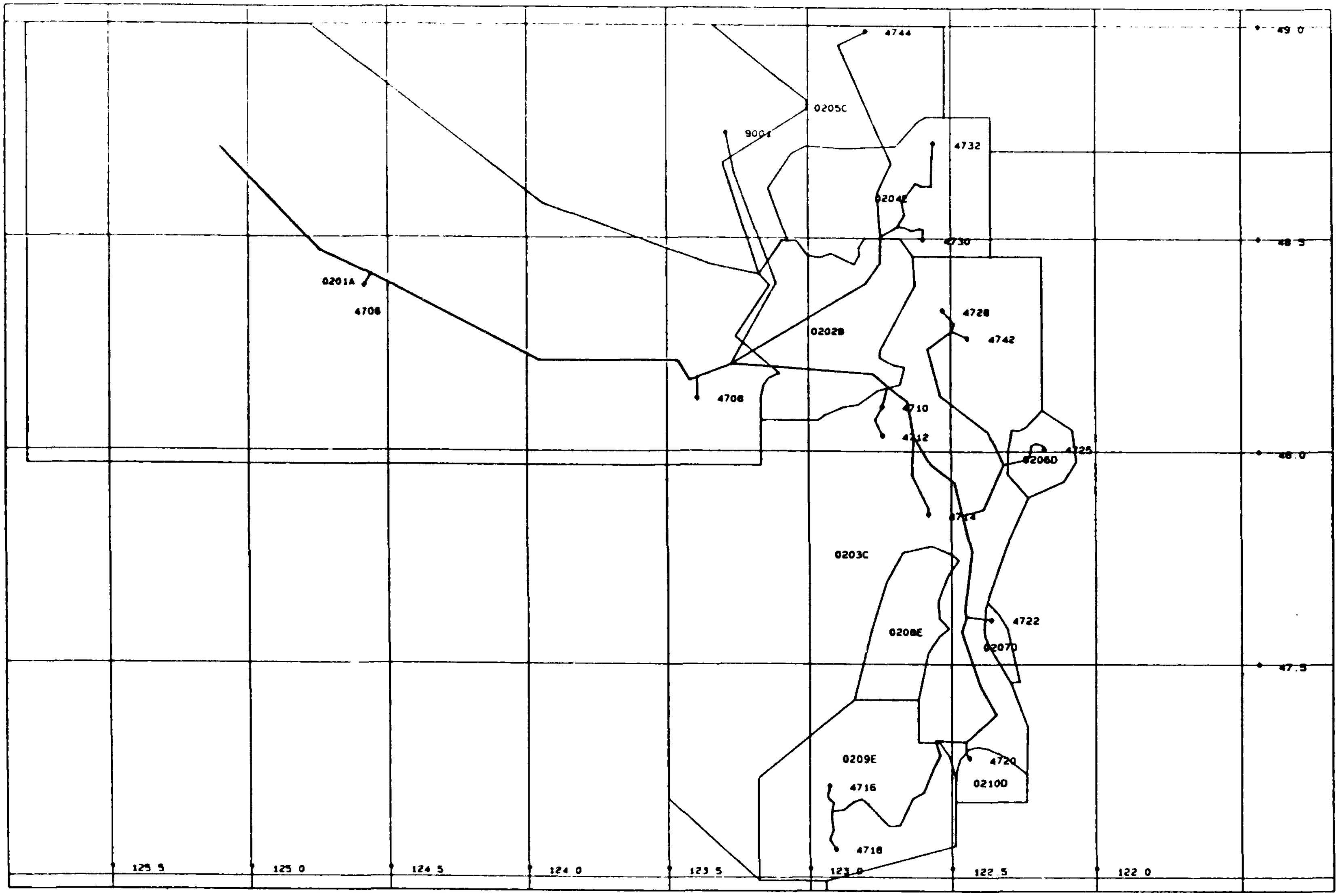
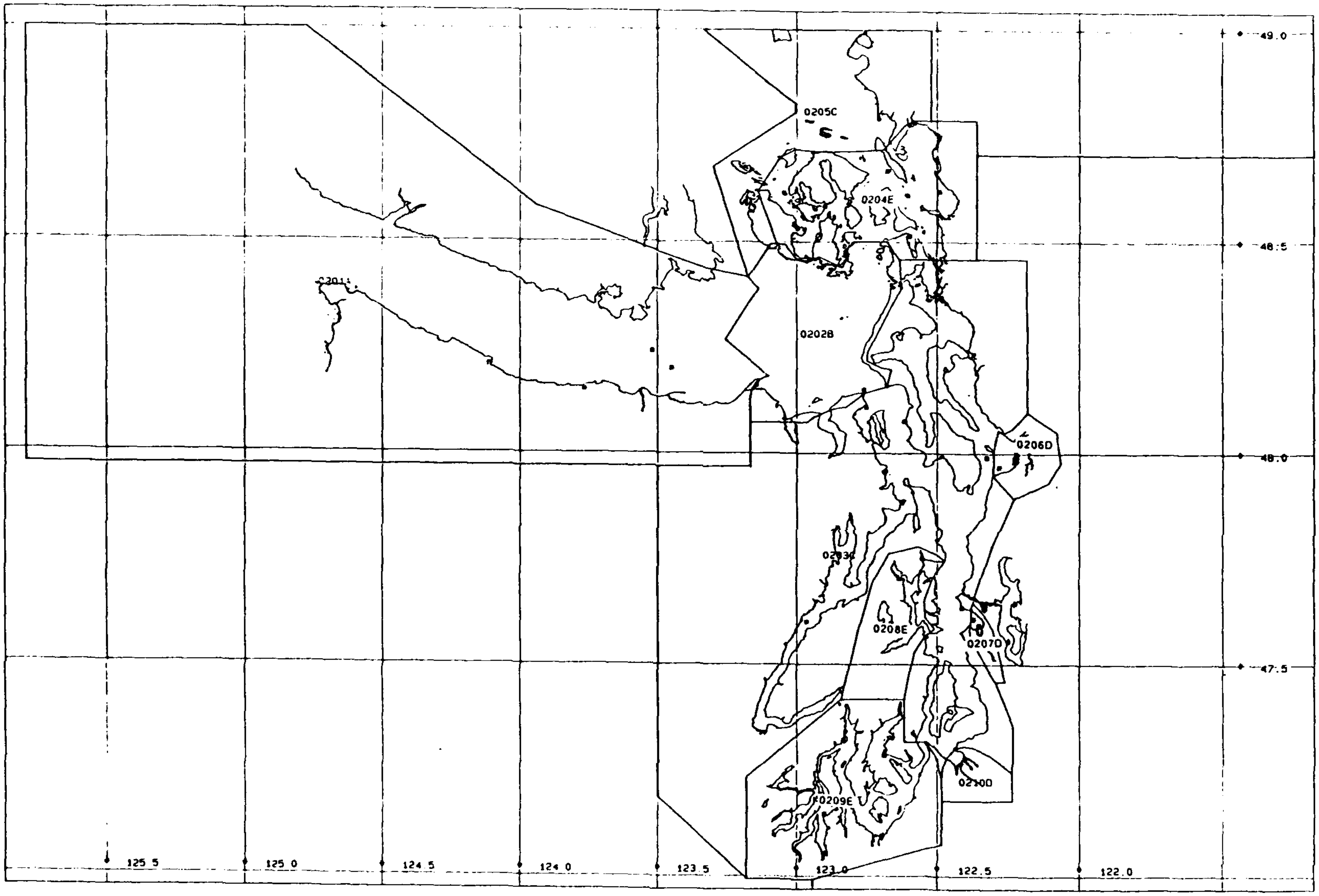
STUDY ZONE MAPS



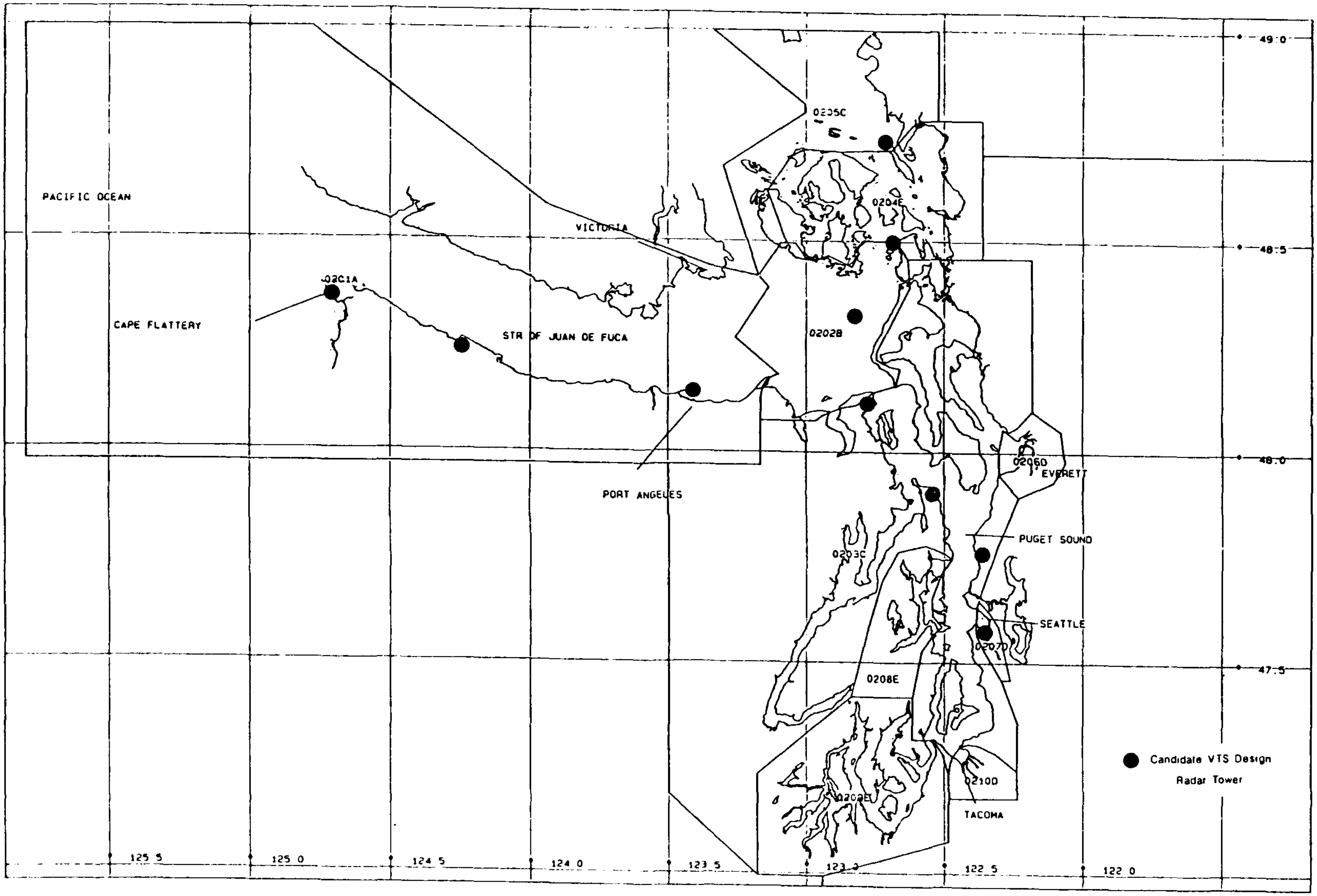
ZONE 2 - PUGET SOUND, WA - ZONE AND SUBZONE BOUNDARIES



ZONE 2 - PUGET SOUND, WA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 2 - PUGET SOUND, WA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 2 - PUGET SOUND, WA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PUGET SOUND, WA

(ZONE 2)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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APPENDIX

1.0 SCOPE

This report includes a port survey and a VTS design for Puget Sound. Figure 2-1 is a summary of the surveillance chosen for the Puget Sound VTS zone. Figure 2-2 represents the final system design in block diagram form. The port survey is based on a visit to the port, a physical inspection of problem areas, extensive interviews with key personnel, and a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in VTS Technology Survey, Vol. III, Technical Supplement. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PUGET SOUND SURVEY

2.1 INTRODUCTION

Puget Sound is a major inland waterway system serving the United States and Canada. The area is growing rapidly in population and activities, but overall remains reasonably unspoiled. Although traffic levels are moderate, given the expanse of the area of navigable water, a significant percentage of vessel movements carry pollutants or large numbers of people. The consequences of major marine incidents are therefore potentially high in terms of lives, environmental consequences, political and economic impact.

2.2 OVERVIEW OF THE PORT

"Puget Sound", as discussed in this report, includes the Strait of Juan De Fuca, its seaward approaches, and area encompassed by the Puget Sound Vessel Traffic Service (VTS) Area. The Puget Sound VTS area is described in "Puget Sound Vessel Traffic Services User Manual" in the following manner:

> "The VTS Area consists of the Navigable waters of the United States which are inside of a line drawn from New Dungeness Light northerly to Puget Sound Traffic Lane Entrance Lighted Buoy 'S'; thence to Rosario Strait Traffic Lane Entrance Lighted Buoy; thence to Hein Bank Lighted Bell Buoy; thence to Cattle Point Light on San Juan Island; thence along the shoreline to Lime Kiln Light; thence to Kellett Bluff Light on Henry Island; thence to Turn Point Light on Stuart Island; thence to Skipjack Island Light; thence to Sucia Island Daybeacon '1'; thence along the shoreline of Sucia Island to a point at 48-46.1'N, 122-53.3'W; thence to Clements Reef Buoy '2'; thence to Alden Bank Lighted Gong Buoy 'A'; thence

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I	1		1							1	1		1						
II	1									2		1							
III	1		1							1	1		1						
IV	1									2		1			1				
V	1									1			1						
VI	1									1	1								
VII	2									1			1						
VIII										1									

FIGURE 2-1. PUGET SOUND, WA, VTS SURVEILLANCE SURVEY

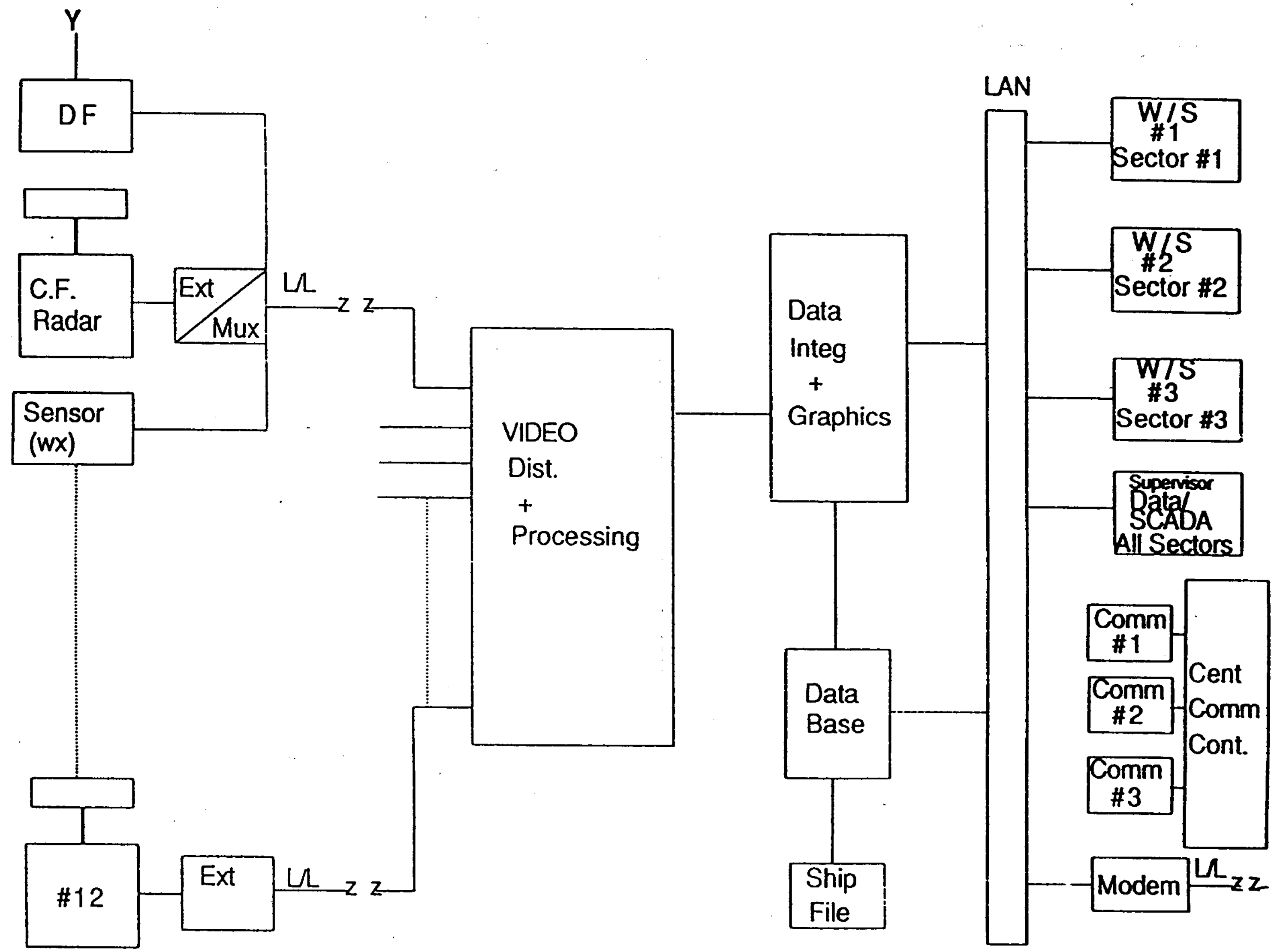

FIGURE 2-2. PUGET SOUND, WA, VTS BLOCK DIAGRAM

northerly to the westernmost tip of Birch Point at 48-56.6', 122-49.2'W" (Reference 1).

The area contains nearly all of the Navigable Waters of the United States inside of the entrance to the Straits of Juan De Fuca. It is a major waterway system, incorporating the ports of Seattle and Tacoma and several less commercially important ones. These include:

Port Angeles	Bellingham	Olympia
Port Townsend	Edmonds	Anacortes
Everett		

Three U. S. Navy facilities are served by the waterway; The Submarine Base and Ammunition Depot at Bangor, the Naval Shipyard at Bremerton and the base for a Carrier Battle Group now under construction at Everett.

The waterway is used by both intra- and interstate barge traffic, including those that move large rafts of logs. It supports extensive recreational and commercial fishing, and is home to a multitude of pleasure craft. Fishing issues are complicated by Federal Court rulings regarding Indian Fishing Rights under 19th century treaties. Major Fisheries include salmon, clams and oysters. In season, fisheries considerations pose major traffic management problems.

The Sound can be considered a highway in one sense. It is extensively criss-crossed by ferries operated by Washington State as an extension of its highway system. Ferry movement is the major component of the Sound's vessel traffic, a fact supported by statistics developed by the Puget Sound VTS. Of the average 600 vessel movements per day processed by the VTS, some 70+% are by ferries.

Perhaps the most striking feature of the waterway system is the depth of water that prevails throughout most of it. The main channels tend to exceed 200 feet in depth, and deep water is carried nearly to the banks in most areas. The South Puget Sound area and portions of the eastern shore north of Edmonds differ from this norm, with considerable stretches of shoal water and tidal flats. Isolated hazards to navigation tend to be concentrated around the San Juan Islands and the remainder of the area is surprisingly free of navigational hazards. The range of tide exceeds 14 feet and tidal currents can exceed six knots at maximum in constricted channel such as the Tacoma Narrows and Rosario Strait.

One unusual feature of the Puget Sound waterway is that portions are shared with Canada. Traffic bound to and from Canadian ports pass through U. S. waters and traffic outbound from U. S. ports

Cooperative traffic management is discussed in more detail in Section 3, below.

Seattle is a major commercial port, with a considerable volume of container traffic (approx. 1.2 million TEU/year). There is also a mix of bulk and general cargo, including automobiles. Petroleum carriage within the Port of Seattle is generally limited to refined products in relatively modest amounts. Some bunkering occurs in the port. Future growth of the Port of Seattle may well be dictated by the paucity of space in which to expand, and by environmental constraints. (One expansion scheme has already been abandoned for that reason.)

Tacoma is growing rapidly, and is approaching Seattle in terms of container volume (1+ million TEU/year) and general cargo movement. It may develop more rapidly than Seattle since the Port of Tacoma has space to accommodate significant expansion. Commencement Bay, Tacoma's outer harbor, is extremely deep and in consequence Tacoma-area anchorages are limited in number. Indian treaty issues may result in the imposition of severe traffic restrictions during salmon fishing season. If that occurs, good marine traffic management will be essential during such periods.

Three major oil refineries are located near and north of the San Juan Islands, and there are a number of oil terminals throughout the Puget Sound region. In 1989, 44,010,662 barrels of petroleum of all types was transported on Puget Sound by 1081 vessel movements (Reference 2). The crude oil processed by the refineries is delivered by ship, with tanker traffic being a major concern to the citizenry throughout the state. The concern has manifested itself in state regulations governing the size and other characteristics of tankers using Washington waters, the recent formation of an oil spill contingency response program, and legislation dealing with oil spill prevention, containment and cleanup. It is interesting to note that public concern about tanker traffic was the driving force which brought the existing VTS to Puget Sound.

Those considering vessel traffic management issues should be aware that protection of the environment of the Sound is of major concern to the peoples of the Pacific Northwest. There are numerous, well-organized groups active in keeping this concern before state and federal government. The EXXON VALDEZ incident has intensified environmental activities, and has tended to focus attention on issues of vessel traffic management, safety, and spill prevention. Vessel movement within Puget Sound has been characterized by extremists as extremely heavy. A more realistic view is that, while there are some challenging traffic management problems, the overall density is low and the risk of collision is correspondingly low. There are, however, specific locations within the waterway system where densities sporadically reach levels of greater-than-normal risk. These are discussed more fully in Section 7. Detailed information about Puget Sound ports may be

obtained from the "Port Series" of reports published by the Water Resources Support Center, U.S. Army Corps of Engineers. Applicable reports include:

Port Series No. 35, "The Ports of Tacoma, Greys Harbor and Olympia"
Port Series No. 36, "The Port of Seattle"
Port Series No. 37, "Ports of Port Angeles, Port Town send, Everett, Anacortes, and Bellingham"

Additional information appears in the Coast Pilot (Reference 3).

The International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) apply throughout.

2.3 EXISTING TRAFFIC MANAGEMENT

The Puget Sound Vessel Traffic Service is well documented by the U.S. Coast Guard. Therefore, discussion will be restricted to providing basic background information and commenting on current status, planned improvements, and the effect of the VTS on traffic management through the Strait of Juan de Fuca and Puget Sound.

The Puget Sound VTS has matured steadily since its inception in 1972 when Traffic Separation Schemes (TSSs) and communications formed the backbone of this service. Since being made mandatory in 1974, the VTS has become incrementally more influential on the management of marine traffic. Since 1975, radar has played an important role in VTS operations and currently the 10 separate radar sites provide excellent coverage of the Strait of Juan de Fuca, Rosario Straits, and Puget Sound from Point Wilson south to Vashon Island.

Operations in the Vessel Traffic Center are very "people intensive". One operator at a console manages 3 radars in the Strait Sector, another operator at a separate console manages 4 radars in the Northern Sector, and a third operator/console manages three radars for the Southern sector. Thirty-three military and fifteen civilians operate the Vessel Traffic Center.

Vessel information is recorded on 3-1/4" x 7" cards which are physically passed between consoles as the vessel transits the VTS. While this method does work, the traffic information on the cards, except for certain selected data saved manually each day, is not maintained in a data base and becomes filed.

The Precautionary Areas at the intersection of the Strait of Juan de Fuca and Puget Sound represent the Traffic Center's most intensive traffic management area. The last 15 miles of a vessel's transit to and from Tacoma is managed by the Traffic Center using magnetic ship models and dead-reckoning on a vertical plot. Movement reports are relied upon to determine transiting vessel locations. There is no VTS radar coverage in this area.

Planning Proposal 13-001-89 for the Thirteenth Coast Guard District proposes the installation of two additional radars to cover the southern reaches of Puget Sound into the Port of Tacoma. One radar would be installed on Coast Guard property at Point Robinson and the other would be installed near Commencement Bay. The radar data would be transmitted to the Vessel Traffic Center by fiber optic telephone lines and integrated into computer enhanced displays. This project is now planned for completion during 1992.

Another Planning Proposal (13-002-89) calls for replacement of the existing 1970's-vintage radar displays in the Vessel Traffic Center with daylight viewing, computer enhanced mosaic models which could integrate several radars on one display. Remote radar extraction and digital conversion is also recommended to reduce/replace the need for expensive microwave relay.

The VTS utilizes eight low-level (1-watt) VHF-FM transmitter/receivers (upgraded in 1984) strategically located throughout the VTS region. These provide adequate communications most of the time but occasionally it is necessary to transmit on one of the three high-level sites particularly when traffic is congested or when normal fade or interference is experienced by a low-level site. This means that the VTS must communicate on CH 13 at relatively high power (10-watts) from time to time. Plans to improve low-level capability include replacing the Bush Point low-level site with three sites on Wilson Point, Point No Point and at Mukilteo. The low-level site at Brown's Point would be relocated to improve coverage of Commencement Bay and South Sound.

Recently, an additional VTS radio channel (CH 5A) was assigned to relieve congestion on CH 14. This simplex frequency (156.25 MHz) is the designated VTS working channel for the Strait of Juan de Fuca, waters east of Whidby Island, and the northern waters surrounding Rosario Strait. Channel 14 will remain the VTS channel south of Lagoon Point. Because CH 5A is a U.S. and not an International (duplex) channel, foreign vessels are having difficulty complying. Gradually the shift will be accommodated but in the meantime, CH 14 is still being used heavily in the northern areas.

Because vessel traffic in the Puget Sound VTS monitors CH 14, this channel frequently is used to exchange bridge-to-bridge information rather than CH 13. The pilots state that they normally use the vessel's onboard radio equipment for communicating on CH 13 and CH 14 reserving their handheld transceivers for tug communications. Thus when they are operating on CH 14 in the VTS and a bridge-to-bridge situation arises, it is far easier to simply use CH 14 for this short exchange than to have vessel personnel shift their onboard radio equipment to CH 13. This means that both CH 13 and CH 14 are used for bridge-to-bridge communications in the Puget Sound VTS. Channel 13 also is used by Seattle locks and bridges near the VTS which leads to congestion and interference problems particularly during weekends when recreational boaters are calling for bridge openings.

The Puget Sound VTS serves as the sensor and command and control center for the USCG Marine Safety Office (MSO) and plays an important role in Maritime Defense Zone planning by the Commander, Coast Guard Forces Seattle (one of the COTP's responsibilities). The VTS provides an instant "picture" of the status of Puget Sound whenever a problem arises requiring Coast Guard action. VTS sensor information is utilized for conducting normal Coast Guard operations by Group Seattle through which the Captain of the Port (COTP) exercises command and control of on-the-water enforcement resources. Certain COTP enforcement for commercial and private traffic is conducted through the VTS communications system. While the VTS normally works most closely with the COTP and MSO, the Aids to Navigation branch of the District Commander's staff exercises VTS Program responsibility.

Because the VTS has such excellent radar coverage, it is capable of "managing" VTS non-participants by advising others and working with individual groups such as yachting organizations. However, gillnet fishing creates peculiar problems affecting everyone who uses Puget Sound. For a few weeks of the year, gillnetters "fish wherever they want" and every maritime group interviewed commented on how this fishing activity burdens their operation in some way. The VTS cannot radar track each individual fishing boat among the hundreds that fish in the TSS. Although the Gillnetters are supposed to clear the TSS for approaching traffic, they often fail to do so and the VTS is often unable to advise large vessels how to avoid them. On-the-water enforcement by Coast Guard vessels has helped to keep the TSS clear but considerable risk exists for collision with the fishermen or between transiting vessels and ferries trying to avoid them.

Since 1983, Temporary Special Traffic Lanes (TSTL's) have been established to resolve the fishing issues which exist seasonally in Puget Sound. This compressing of two-way traffic flow into a 1/2 mile wide special lane has not proven to be effective nor to

enhance safety and will be canceled. Proposed new rules will permit fishing in the traffic lanes but will require that the lanes be cleared before arrival of through traffic. In addition, fishing will be prohibited in several Puget Sound ferry crossing areas and there will be restrictions covering Hood Canal submarine transits.

English language problems with inbound vessels before they take a pilot is a problem to the VTS. The Pilots report related problems of ensuring that their commands are understood by shipboard personnel. The VTS operators are learning to speak slowly and in simple terms when working with foreign vessels.

There have been several cases where a vessel inbound west of the Pilot station has failed to heed the course change necessary to proceed safely through the Strait of Juan de Fuca. Again, language has been a problem in conveying advice on this issue and the VTS is now capable of initiating an "alarm" signal on the VHF-FM radios channels when a transiting vessel fails to communicate and appears headed for danger.

Rapidly changing wind and weather conditions are of concern to the VTS which now relies upon reports from transiting vessels for this information. Future planning calls for the use of remote wind, weather and fog sensors to keep the VTS advised of conditions affecting advice and decisions made by the center.

U.S. radar coverage of the entrance to the Strait of Juan de Fuca is better than the radar coverage by the Canadians for their area of VTS responsibility. A test project is being planned to transmit radar information from the Puget Sound VTS to the Canadian control station at Tofino. Puget Sound Vessel Traffic Center reports having seen close calls and other traffic management problems in the Precautionary Zone just off the entrance and hopes the better radar coverage by Tofino will help eliminate this situation. Canadian VTS regulations went from Advisory to Mandatory during April 1990 and this also may help.

Ferries operating in the VTS are required to announce their departures five minutes ahead. The ferry operators admit that when CH 13 is congested, they sometimes cannot make the required announcement and then get busy undocking and forget to call. A transponder system could assist the VTS in identifying and tracking ferries which are crossing the TSS and alleviate this problem however, other waterway users depend on some radio announcements of ferry crossings particularly those operating tugs with tows.

The VTS has some difficulty with Naval vessels not monitoring CH 14 although they are required to do so by Commander Naval Base. Seattle. VTS frequently has to chase them on CH 16 or CH 13 to get them to comply.

While the Port Angeles Pilots have been the source of considerable criticism of the VTS in the past, this has changed markedly. Pilots now participate with watchstanders in the Center Every third day building rapport and mutual confidence. The Pilots are now included in the "decision support" scheme of the Center and advice and information provided to transiting vessels is much more readily accepted and used.

2.4 VESSEL TRAFFIC

Vessel traffic statistics are available for the various ports within Puget Sound, but are generally documented in a fashion which makes it difficult to determine with precision the traffic volume at given points within the waterway complex. The numerical base of movements of blue-water ships is relatively clear, but other significant elements--fishing, log transport, tugs--are less so. Total movement statistics kept by VTS Seattle, averaging about 600 per day within the Puget Sound VTS Area, are misleading because some 73% of the recorded moves are made by ferries along scheduled routes. Of the remaining movements, perhaps only 30 per day involve large ships. The resulting maximum of fifteen inbound and fifteen outbound ships per day is sufficiently accurate for VTS-related planning, always bearing in mind that in the Strait of Juan De Fuca that figure is increased significantly by traffic to and from Vancouver and other Canadian ports. Good statistics are available about the movement of petroleum products, and extracts from material furnished by the Western States Petroleum association is attached as an enclosure hereto.

Tank vessels transiting Puget Sound are limited by regulation to not larger than 125,000 DWT (Reference 4).

2.5 ENVIRONMENTAL SENSITIVITY

(Reference should be made to NOAA charts 18400 and 18440.)

NOAA Chart 18400

Generally speaking, both shores of the Strait of Juan De Fuca are pristine, undeveloped and host to much aquatic animal and bird life. The shorelines are generally rocky, but there are large tidal expanses at and east of Dungeness. Around Victoria, British Columbia, the rocky shoreline is the site of considerable development and recreational activities.

The San Juan Island area is pristine, but with somewhat more development than in the Strait of Juan De Fuca. Most of the shoreline building in the San Juans is residential or recreational in character. The shoreline is host to significant quantities of aquatic life and the entire area

is under consideration for designation as a marine sanctuary. The San Juan area is important from a recreational standpoint and, in season, recreational boat traffic within the island area is heavy.

From the Fidalgo Peninsula Northward the U.S. coast is marked by tidal flats and marshes of considerable importance to migrating aquatic birds. The rivers feeding into the Sound are also important spawning grounds for fish of several species.

NOAA Chart 18440

The Hood Canal supports economically important fishing grounds and clam and oyster beds. The shoreline tends to be sandy, with high bluffs, and is generally undeveloped except around the few towns sited upon the water. The area east of Whidby Island has similar characteristics, but is not so important from the fisheries perspective. From Everett south, the region is heavily populated and may be considered part of Greater Seattle. South of Whidby Island, shorelines exhibit similar characteristics to a point south of the Tacoma Narrows. The region between Whidby Island and Commencement Bay is a major fisheries area, with the most valuable harvest probably being salmon.

South of the Tacoma Narrows, the shoreline is a mix of low- and high-bank glacial moraine. The entire southern shore represents an important tidelands area, and the region around Nesqually Flats is a wildlife refuge. The South Sound area supports extensive fisheries.

On balance, the entire Puget Sound area must be considered as environmentally sensitive. The economic and political consequences of a major spill, for example, would be enormous. More detailed information is available from the library of the National Oceanic and Atmospheric Agency, Western Region, Seattle.

2.6 PORT SUB-ZONES

Puget Sound was examined to determine appropriate sub-Zones, using a methodology based upon the "confined-complex", "open- complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 5). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

Eight distinct sub-zones were identified.

2.6.1 Sub-Zone I - Puget Sound Western Approaches. (NOAA Chart 18460)

The Western Approaches Sub-Zone lies to seaward of 124-40' West Longitude.

The approaches to the Strait of Juan De Fuca present a series of discrete traffic management concerns. Traffic movement tends to appear random since ships are arriving from, and making departure for, three distinct areas: Continental U.S. ports and the Panama Canal; Alaska; and, by Great Circle, the Orient. Depending upon the season, the area is heavily fished and the U.S. Navy conducts operations (usually to the SSW of Swiftsure Bank). The pilot stations for both Puget Sound and Canadian ports lie some 60 miles inside the Strait, and poor communications between ships within the Approaches is common, because of language problems without English-speaking pilots aboard. Weather conditions can also be quite severe, and visibility of less than two miles occurs about 5-8% of the time. The area is served by Tofino Traffic, of the Canadian VTS system, but radar coverage is not good.

2.6.2 Sub-Zone II - Strait of Juan De Fuca. (NOAA Charts 18400)

The Strait of Juan De Fuca Sub-Zone lies between 124-40'West Longitude and the western boundary of the Puget Sound Vessel Traffic Service Area. The northern boundary of the Sub-Zone is marked by a line drawn from Hein Bank Lighted Bell Buoy westward to Race Rocks Light (Off Cape Carver, Vancouver Island, British Columbia.

Much of the sub-zone is governed by an IMO-sanctioned Traffic Separation Scheme, all of which lies to the west of the pilot stations for Puget Sound and Canadian waters. The area is under radar surveillance by VTS Seattle and the VTS communications system covers the Strait. Participation by ships in the Puget Sound Traffic System is on a voluntary basis, but is expected to be made mandatory in the near future.

Communications between ships, and between ships and VTS Puget Sound (Seattle Traffic), can be difficult because of problems with the English language while no pilot is aboard.

The pilot station for Puget Sound lies just north of Port Angeles, and that for Canadian waters nearly opposite, is just south of Victoria. One grounding, with an associated oil spill, has occurred in recent times while the ship was

maneuvering incident to picking up a pilot. Port Angeles has been active in the overseas shipment of logs and is a terminus of some barge traffic (wood products).

The TSS has a dogleg at a point near the center of the sub-zone. At least one inbound ship has failed to change course to conform to the change, resulting in a grounding near Crescent Bay.

A ferry crosses several times a day between Port Angeles and Victoria and traffic in the Precautionary Area at the eastern end of the sub-zone exhibits the random pattern resulting from the intersection of several TSS's.

Seas can reach significant height throughout the sub-zone, particularly when strong westerlies are coupled with westerly seas and swells in the Approaches. Wind and sea conditions can be exacerbated by the channeling effect of mountains on either side of the Strait.

2.6.3 Sub-Zone III - Eastern Bank. (NOAA Charts 18465 and 18441)

The Eastern Bank Sub-Zone lies east of the western boundary of the Puget Sound Vessel Traffic Service Area and west of the line between Admiralty Head (Whidby Island) and Marrow stone Point (Marrowstone Island). The northern boundary of the Sub-Zone is formed by a line drawn from Cattle Point (San Juan Island) to a position at 48-20'N 122-40'W.

The Eastern Bank sub-zone is criss-crossed by four separate but interrelated TSS's and contains two Precautionary Areas. Much of the sub-zone is a designated USN Operating Area and a Restricted Zone used for air-to-surface gunnery practice lies just west of Smith Island.

On the east, Admiralty Inlet is a funnel through which all traffic between Puget Sound ports (except for Bellingham, Anacortes and the northern oil refineries) and the sea must pass. Although not restrictively narrow, the approach to Admiralty Inlet requires care in navigation, particularly during reduced visibility.

Barge traffic can experience problems from strong westerly winds and seas, and can be taken unawares when entering the sub-zone from the sheltered waters of Admiralty Inlet and Rosario Strait.

The sub-zone is a holding area for ships awaiting trans it of Rosario Strait, a one-way channel for large ships.

2.6.4 Sub-Zone IV - San Juan Islands. (NOAA Chart 18400)

The San Juan Islands Sub-Zone is comprised of that portion of the Puget Sound Traffic Service Area which lies north of a line drawn from Cattle Point (San Juan Island) to a position at 48-20'N 122PtoPt-40'W.

The San Juan Islands Sub-Zone contains the waterway's major oil refineries, and is thus subject to significant tanker movement. In 1989, for example, one of the terminals (Cherry Point) was served by 158 tankships, all of which moved through the sub-zone.

Currents through Rosario Strait are strong, approaching six knots at maximum. Tankers moving through Rosario Strait are accompanied by an escorting tug, speed restrictions apply, and the Strait is regulated as a one-way channel for large ships.

Rosario Strait (Buckeye Shoal) is the site of the 13th Coast Guard District's "Worse Case" pollution scenario. This scenario envisions a tanker grounding, with subsequent cargo tank rupture, involving a major spill of crude. The spill would be carried throughout the region as the result of tidal action.

Scheduled ferry service from Anacortes westward to the San Juan Islands and to British Columbia transits Rosario Strait on a frequent schedule.

Some tanker anchoring (while awaiting berths at terminals), and lightering occur east of Vendovi Island.

The sub-region, except for the area east of Sinclair Island, is under radar surveillance by Puget Sound VTS.

The sub-zone, in addition to the oil terminals, contains some of the region's most environmentally sensitive areas.

2.6.5 Sub-Zone V - Northern Puget Sound. (NOAA Chart 18440)

The Northern Puget Sound Sub-Zone lies between a line between Admiralty Head (Whidby Island) and Marrowstone Point (Marrow stone Island) and a line drawn westward from West Point. It also includes the Hood Canal and the waters east of Whidby Island.

The sub-zone is traversed by a ferry route between Kingston, on Bainbridge Island, and Edmonds, and there is another between Port Townsend and Whidby Island. The northern portion of the sub-zone is the site of some of the heaviest fishing during salmon season, an occasion which poses severe traffic management problems.

Shilshole Marina, operated by the Port of Seattle, is the largest marina in the Seattle area and is sited on the eastern shore north of West Point. Between West Point and West Point is the Sound terminus of the Ship Canal giving access to Lakes Union and Washington. The Seattle Fishermen's Terminal lies inside the Canal and there are a number of small shipyards and other commercial enterprises there. The Shilshole-Lake Union-Lake Washington complex is where the majority of the pleasure craft operating within the zone are moored.

There are general and explosives anchorages at and near Port Townsend.

2.6.6 Sub-Zone VI - Seattle. (NOAA Chart 18440)

The Seattle Sub-Zone lies South of a line drawn westward from West Point and north of an east-west line drawn tangent to the northern end of Vashon Island. It includes Rich Passage and Sinclair Inlet.

The Seattle Sub-Zone is the site of considerable activity. The principal ferry terminal serving Seattle is sited on the east side of Elliott Bay, with frequent and heavily used service to Bremerton, Bainbridge Island and Vashon Island. The ferry traffic interlaces with shipping serving the Port of Seattle, with local tug/barge traffic and with recreational activities such as tour boats. Although there are pleasure craft which are moored within the sub-zone, the number is small by comparison with Sub-Zone V, and the Bay is not heavily frequented by boaters. There is an anchorage area within Elliott Bay which, while deep, accommodates ships awaiting berths and bunkers. Another common although undesignated anchorage area lies to the west of Blake Island.

Across the Sound from Seattle lies Rich Passage, leading to Bremerton. Just south of the entrance to Rich Passage is a USN fuel deport and inside, at Bremerton, is the Puget Sound Naval Shipyard. Large ships, including carriers, are overhauled there but naval traffic is sporadic rather than heavy.

Another ferry route runs cross-Sound, just north of the southern limit of the sub-zone.

2.6.7 Sub-Zone VII - Tacoma. (NOAA Chart 18440)

The Tacoma Sub-Zone lies south of an east-west line drawn tangent to the northern end of Vashon Island and north of a line drawn westward from Point Defiance. It includes Commencement Bay and the Port of Tacoma.

In general, the only large ship traffic using this sub-Zone is that calling at the Port of Tacoma, although several ships per month transit the sub-zone enroute to and from the Port of Olympia. Overall, Tacoma's level of activity is much lower than Seattle's, primarily because of the absence of ferries.

Tacoma's outer harbor, Commencement Bay, is deep and therefore anchorages exist only near the northern shore and adjacent to the mount of the Puyallup River. The Puyallup Indian Tribe is attempting to assert treaty fishing rights throughout Commencement Bay and this may lead to a loss of anchorages and the establishment of a narrow transit lane for ships through the Bay.

There is a minor ferry route between Vashon Island and Point Defiance, posing little problems for Olympia traffic or for the occasional ship departing Tacoma via Colvos Passage. There is heavy recreational fishing near the mouth of The Narrows and south of Vashon Island.

2.6.8 Sub-Zone VIII - South Puget Sound. (NOAA Chart 18440)

The South Puget Sound Sub-Zone lies south of a line drawn westward from Point Defiance, including the Port of Olympia.

The South Puget Sound Sub-Zone is only lightly traveled by commercial shipping, with some barge traffic in logs and aggregate and the occasional ship calling at Olympia. There are several small ferries which ply between the South Sound islands and the mainland, but the schedules are generally infrequent. Recreational boating is light, except in the vicinity of Olympia. Few traffic management problems exist in this sub-zone.

2.7 PROBLEM AREA IDENTIFIERS

The identification of locations prone to groundings, collisions and other problems was accomplished by analysis, refined in some cases by visits to the areas in question and through interviews with representatives of the maritime community. The interview process also permitted consideration to be given to areas of concern to specific elements of the user and/or regulator communities. Although available marine casualty data was insufficient to generate "Accident Black Spots", the information which was available tended to support the conclusions reached through other

means. "Problem Area Identifiers" (PAI) were assigned to each of the locations, with the first number of the PAI identifying the sub-zone in which it is located.

2.7.1 PAI I-1. Juan De Fuca Approaches

The Straits of Juan De Fuca approaches is both the initial landfall and the point of departure for most of the traffic serving the Ports of Puget Sound and British Columbia. To that extent it is a place of sorting out positions and courses, and this introduces a degree of randomness to traffic patterns. Minor errors in navigation, errors in judgment about the effect of wind and/or tide and the process of communicating with other ships and shore stations in what is often a foreign language all incrementally increase navigational risks.

2.7.2 PAI II-1. Juan De Fuca TSS

Although IMO-sanctioned the dogleg in the Juan De Fuca TSS has caused navigational problems and at least one grounding. The risk it presents is amenable to a near-classic TSS application.

2.7.3 PAI II-2. Port Angeles Roadstead

The risk of collision or of grounding incident to boarding a pilot off Port Angeles is statistically low. Incidents have occurred, however, and one contributory cause may be bridge workload during the critical period when ships are maneuvering without pilots. Within recent years, a tanker grounding in this area caused a significant oil spill. VTS assistance may help minimize the potential for similar incidents in the future.

2.7.4 PAI III-1. Admiralty Inlet Entrance

Admiralty Inlet represents one of the narrowest portions of the Puget Sound waterway complex, but does provide ample room for meeting and passing of ships under normal circumstances. Cross-channel traffic bound to and from Port Townsend (mostly recreational, ferries, and fishing boats) can be of concern during periods of heavy use and/or periods of reduced visibility. The existing level of VTS helps provide masters and pilots with a "surprise free" scenario.

2.7.5 PAI III-2. Whidby Island, Western Shore

The western shore of Whidby Island presents two problems. The first is that it is a lee shore, and strong swell systems can develop as the result of offshore storms and high winds through the Strait of Juan De Fuca. Tugs with tows southbound through Rosario Strait or northbound from Admiralty Inlet can,

and have been, surprised by the severity of conditions encountered upon leaving those protective waters. There are incidents of resulting towline and other problems, offering the opportunity of a barge going ashore on Whidby Island, with subsequent damage and pollution.

The area of Eastern Bank is the last "point of no return" for tankers inbound through the Rosario Strait to wait out high gusts or local fog within that channel. Readily available up-to-date information about existing local weather conditions represents an incremental contribution to risk reduction.

2.7.6 PAI IV-1. Rosario Strait

Rosario Strait represents, for large ships, perhaps the most difficult transit within the Puget Sound area. The Strait is used by many small craft and ferries. When this type of traffic is combined with navigational factors such as strong tidal currents, the resulting hazard warrants the imposition of the "one-way" Rosario Strait VTS rule. While surprises do not develop from unexpected large ship movements, radar surveillance is necessary to provide timely advice to tankers about non-participating traffic moving in the Strait.

2.7.7 PAI IV-2. Vendovi Island Roadstead

The Puget Sound pilots have identified the waters around and leading to the Vendovi Island roadstead as an area not under adequate surveillance by VTS Puget Sound. As a result, the potential exists for a surprise meeting at a critical point.

2.7.8 PAI V-1. Point No Point

The area from Point No Point south to West Point tends to degrade to a "madhouse" during gillnetting season. Regulations requiring fishing boats to clear the TSS prior to and during the transit of large ships are only effective in relation to the vigor with which they are enforced. Efforts to have fishing boats guard Channel 13 while fishing have not been marked by success. There is concern on the part of masters, pilots and owners alike that a grounding or collision attributable to efforts to avoid nets or fishing boats is "an accident waiting to happen." In addition to that concern, there is worry about damage and loss of life in the event that a fishing boat is run down.

The gillnetting and general fishing problem extends into other areas of the Sound, but reaches its peak in this area.

2.7.9 PAI VI-1. Rich Passage

Ferries and ships leaving Rich Passage may announce intentions on Channel 13, but these calls are often masked by Bainbridge Island.

2.7.10 PAI VI-2. Elliott Bay

Elliot Bay represents the single most busy traffic spot in the entire system. There is general public concern about collisions in Elliott Bay, and a collision involving a fully-loaded ferry represents "worse case" in terms of hazard to life. The nature of the traffic generates random movement patterns, and larger ships are operating at slow speeds and may have significant problems in responding effectively to unforeseen events. Maneuvers incident to clearing or making berths, tugs alongside or similar activities occupy much of the attention of shipboard personnel, and increase the importance of traffic-related advisories.

2.7.11 PAI-VII-1. Commencement Bay

Commencement Bay anchorage management is important to the flow of traffic to and from berths in the Port of Tacoma. Anchorage space is limited and may become more so in the future. The next nearest anchorage is either in Elliot Bay or west of Blake Island, and both are about 1-2 hours from the Port of Tacoma. Anchorage control coupled with control over speed of advance may prevent serious queuing problems in the future, particularly should use of the present anchorages be suspended during tribal fishing periods.

3.0 PUGET SOUND VTS DESIGN

3.1 INTRODUCTION

A detailed survey of Puget Sound the basis for this design. An approach to costing VTS systems in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The eight sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o The accuracy of the position and track obtained
- o The reliability of the surveillance system
- o The timeliness of the data obtained
- o The ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore (ADS). The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels which interact in this sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may effect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Puget Sound VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o The radar coverage of the Puget Sound area, after the addition of the two radars south of Seattle, is adequate in all sub-zones. The existing radars do not require replacement. Radars being installed at Point Robinson and Browns Point are to have remote scan conversion and target extraction installed.

o The planned communications additions are completed and the existing remote communications facilities are adequate.

o The ocean going vessel traffic density in Puget Sound is light. Inbound and outbound traffic within the VTS area is approximately thirty ship movements per day.

o The two major problems are 1) the potential for an oil spill in a pristine and environmentally sensitive area and, 2) the possibility of fatalities resulting from a ferry accident.

o There is major passenger and car ferry traffic with greater than 400 movements per day.

o All of the petroleum supply for the three refineries in Northern Puget Sound arrives in tank ships.

o The weather and visibility varies greatly from sub-zone to sub-zone.

o There is a large commercial fishing fleet and fishing activity in shipping lanes is a serious problem.

- o Compared to other major U.S. ports, the accident rate in Puget Sound has been low.

- o The VTS system covers a very large area of diverse water systems.

3.2 DESIGN DECISIONS

3.2.1 General

Puget Sound is a very large area with low traffic density and an extensive VTS system in place. Comparison of waterway operations in this area with other similar U.S. and foreign ports leads to the conclusion that there is more of a perception of shipping problems here than there is in fact.

The existing traffic management situations can be condensed into three subsets as follows:

1. The need to keep the probability of oil spills very low in this extremely sensitive and uncontaminated environment. Light oil tanker traffic averages three movements per day and tight VTS monitoring of these vessels is easily accomplished.

2. A large amount of repetitive passenger ferry traffic--400+ movements per day--crosses the existing shipping lanes. The interaction of these ferries with ocean going ships, tugs and barges and the commercial fishing fleet present an opportunity for a significant "loss of life" accident.

3. A significant number of commercial fishing vessels and recreational boats use the shipping lanes. A major surveillance problem is created by small boats constructed of non-reflective material.

When the two Tacoma radars are added the existing VTS system will provide adequate radar surveillance of the entire area of concern. The primary deficiency of the existing VTS system is the need to modernize the present vessel traffic control center. Minor complications include a need to modernize radar data handling in order to reduce the current microwave system, the addition of meteorological and hydrological sensors, and the need to improve ship identification. The existing remote communications equipment is adequate and need not be replaced. It is apparent that the surveillance and communications workload created by the repetitive ferry crossings and the channel interference caused by commercial fishing boats must be reduced through enforced regulation and VTS automation.

Based on the above information, the design decisions for Puget Sound are:

- o Modernize the VTS control center
- o Install remote video processing at all radar sites
- o Add meteorological/hydrological sensors throughout the VTS zone
- o Separate communications channels for all three sectors
- o Improve the ship identification system for the VTS entry area
- o Add Automatic Dependent Surveillance (ADS) to all ferries in the form of active radar beacons. This involves research and development and rulemaking by the U.S. government. This method of ADS is selected because it provides identity and enhanced detection to the VTS as well as enhanced detection for ship radars.

The Puget Sound sub-zones outlined in Section 1 were inspected in order to divide the VTS area into logical control sectors. These are:

Sector 1: Sub-zones I & II

Sector 2: Sub-zones III, IV and that portion of Sub-zone V north of Bush Point

Sector 3: The remainder of Sub-zone V plus Sub-zones VI, VII and VIII.

3.2.2 Sector 1 - Sub-zones I & II

3.2.2.1 Discussion

These two sub-zones combined encompass a large area of approximately 1000 square miles and have similar obstacles. The area is dominated by IMO sanctioned Traffic Separation Schemes. The weather can be unstable with high wind potential, major swells and low visibility. Several times a day a ferry crosses from Port Angeles to Victoria B.C. Since harbor pilots board ships at Port Angeles, only the ships in the eastern portion of this sector have pilots aboard. This situation creates language problems and other operational complications for VTS watchstanders who deal with ships west of Port Angeles. Communications between the VTS and vessels in the area is on Channel 5A. This is not an internationally recognized frequency in the VHF band and is not normally available on the transceivers carried by foreign ships. There is no direction finding equipment available and occasionally vessels

entering the VTS zone can be confused with other coastal traffic due to the large open water areas. The identity problem is compounded by language difficulties as mentioned above. There is no method of measuring the rapidly changing wind and weather conditions in the area. Such conditions represent serious navigational hazards and these sub-zones must have complete radar surveillance and low level communications coverage. A vessel-based surveillance system is suitable in this area if additional data on vessels moving into these harbors becomes necessary. There are presently no serious port planning or queuing problems. If, however, a national or international requirement emerges for the carriage of ADS devices on deep draft vessels, this sub-zone represents an area where such data can be employed. Any decision to use or require ADS systems in this area must be coordinated with Canada.

3.2.2.2 Design

The overall technological solution selected for this sub-zone are active radar surveillance, communications coverage, ferry transponders and the existing procedural rules. These decisions are to be implemented with the following hardware:

- o Remote radar video processing for the radar sites at Cape Flattery, Clallam Bay and Port Angeles. Output data is to be sent to the control center over telephone lines.

- o A Module 13 meteorological sensor at Cape Flattery and a Module 12 meteorological sensor at Port Angeles.

- o A Module 16 VHF/DF facility at Cape Flattery.

- o Module 7 ADS devices on the Port Angeles ferries.

3.2.3 Sector 2 - Sub-zones III, IV & V

3.2.3.1 Discussion

These sub-zones comprise a large area with similar problems and traffic density. The three zones are linked by the vessel flow. The traffic to Sub-zones IV and V flows through Sub-zone III and vice versa. Sub-zones IV and V present the problems of sheltered water and narrow channels while wider channels, crossing patterns and the potential for more severe weather exist in Sub-zone III. The major shipping problems in the area are:

- o The two ferry routes from Port Townsend to Whidby Island and from Anacortes to the San Juan Islands create frequent crossings of the established shipping lanes. Almost 62% of the Puget Sound petroleum flow occurs in these sub-zones.

- o Oil tankers transit through the "one-way" channels of Rosario Straights. The Straights have very strong currents and a tug escort is required. Radar surveillance of these areas is already very good and no coverage improvements are necessary.

Dependent Surveillance type systems are chosen for all ferries in this sector. They are not recommended for all other vessels because of the variety of vessel types involved.

3.2.3.2 Design

The overall technological solutions selected for this sub-zone are active radar surveillance, automatic dependent surveillance, communications coverage and the existing procedural rules. These decisions are to be implemented with the following hardware:

- o Remote radar video processing for the radar sites at Smith Island, Shannon Point, Port Townsend and Lummi Island.

- o A Module 13 meteorological facility at Smith Island and a Module 12 meteorological facility at Lummi Island.

- o A Module 15 hydrological facility at Shannon Point. This facility provides the necessary current information for Rosario Straights.

- o Module 7 ADS devices on all ferries.

3.2.4 Sector 3 - Sub-zones V, VI, VII & VIII

3.2.4.1 Discussion

These sub-zones are similar in character, traffic density and navigational problems. Seagoing traffic density is light, there is seasonally heavy fishing and recreational boating and there are numerous ferry crossings. Approximately 40% of the total Puget Sound petroleum flow occurs in these zones. Strongly resembling a very wide river system, all channels in these zones are quite wide with a separation zone between them. Meeting situations are therefore no problem. Crossing traffic such as passenger ferries and obstruction traffic such as fishing boats in the shipping lanes are the major concerns. Sub-zone VIII, though physically similar to Sub-zones V, VI and VII, is different in that its traffic density and accident potential are low enough to require only procedural monitoring.

Dependent Surveillance type systems are chosen for all ferries in this sector. They are not recommended for all other vessels because of the variety of vessel types involved.

3.2.4.2 Design

The overall technological solutions selected for this sub-zone are active radar surveillance, automatic dependent surveillance, communications coverage and the existing procedural rules. These decisions are to be implemented with the following hardware:

- o Remote radar video processing for the radar sites at Point No Point and West Point.

- o A Module 13 meteorological sensor installed at Point No Point and Point Robinson.

- o Module 7 ADS devices for all ferries.

3.2.5 Vessel Traffic Center

The design of the hardware and software is to be modern and capable of operating with reduced staff levels without loss of effectiveness. The Vessel Traffic Center remains in the Seattle area, however, it is recommended that the center be relocated to a high elevation, daylight site with good visual surveillance of Elliot Bay and most of the shipping channels in Sub-zone VI. This is because the visual contact with Elliot Bay and the marine environment in general is important to the mission of the Vessel Traffic Center. This design replaces manpower with modern control hardware and software. The personnel complement envisioned for this center is comprised of three watchstanders and a supervisor. Using the U.S. Coast Guard ratio of five people for every watchstanding billet plus one clerk and a commanding officer, this center can function efficiently with 22 or fewer personnel. The center is to employ the following major sub-systems:

3.2.5.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

o Layering of data in at least four layers to be operator selectable.

o The ability to sector data including sector to sector handoff of targets.

o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features can be obtained by programming changes.

o Complete modern color graphics capability with offset and zoom

o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.5.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides four operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.5.3 Supervisory Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.5.4 Recording Equipment

Time-synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Puget Sound VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware

	Non-recurring (x $1000)	Recurring
<u>Vessel Traffic Center</u>		
VTS Console (includes 3 work stations, 1 supervisory console, and all software for graphics & data integration)	$2500	
Comms Console	200	
Recording Equipment-4 sets	100	
SCADA Equipment (10 radar sites, and central computer display)	1500	
Ancillary Equipment	100	
TOTAL:	$4400	$2000
<u>SECTOR 1 -- Sub-zones I and II</u>		
Remote radar video processing for Cape Flattery, Clallam Bay and Port Angeles	600	300
Module 13 (met) at Cape Flattery	40	5
Module 12 (met) at Port Angeles	20	5
Sub-total	$ 660	$310
<u>SECTOR 2 -- Sub-zones III, IV and V</u>		
Remote radar processing at Smith Is. Shannon Point, Port Townsend and Lummi Is.	800	400
Module 13 (met)-Smith Is.	40	5
Module 12 (met)-Lummi Is.	20	5
Module 15 (hyd)-Shannon Point	50	5
Sub-total	$910	$415
<u>SECTOR 3 -- Sub-zones V, VI, VII, and VIII</u>		
Remote radar video processing at Point No Point and West Point	400	200
Module 13 (met) at Point No Point	40	5
Module 13 (met) at Point Robinson	40	5
TOTAL:	$480	$210
TOTAL HARDWARE COSTS:	$6450	$2935

3.3.3 Total Project Costs (x$1000)

Hardware	$6450
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required, Existing radars used	3225
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no problem	645
Spares & Training (10%)	645
Civil Engineering Assumptions: Building modification at West Point, land acquisition	500
PROJECT ESTIMATE:	$11465
Data Base Management System	300
TOTAL: (non-recurring)	$11765

TEN-YEAR O&M RECURRING

Hardware	$ 2935
3 Watchstanders x 5 = 15 man/years @ 50K/yr	7500
1 Supervisor	2500
1 Officer-in-Charge	2500
1 Clerk	2500
TOTAL;(recurring) (10-year life)	$17935
TOTAL 10-YEAR PROJECT COST:	$29670

3.3.4 Non-government Costs

	Non-recurring	(10-yr) Recurring
ADS Hardware for ferries (35 vessels)	$70	$35

REFERENCES

1. Puget Sound Vessel Traffic Service Users Manual, USCG VTS, Seattle, April 1987.

2. Report Prepared for the Western States Petroleum Association, University of Washington, Seattle, 1989.

3. United States Coast Pilot, Pacific Coast: California, Oregon, Washington, and Hawaii, 25th Edition, NOAA, Washington, D. C., pp. 253-325.

4. Title 33, Part 160, Code of Federal Regulations, Para. 161.143, Washington, D. C.

5. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area, normally an intersection, entrance to, or exit from a traffic separation scheme, where vessel interactions are unpredictable

SCADA: Supervisory Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

COST SAVINGS DERIVED USING EXISTING SURVEILLANCE EQUIPMENT

PUGET SOUND (Excluding USCG Radars and Communications Equipment)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (3 workstations one supervisory console & all software)	2500	
Comms Console	200	
Recording Equipment	100	
SCADA Equipment (10 radar sites)	1500	
Ancillary Equipment	100	
Sub-total:	4400	2000
Sub-zone I and II		
1 Module 3 radar	400	400
2 Module 1 radars	620	620
1 Module 13 MET	40	5
1 Module 11 VHF	48	20
3 Module 10 VHF	57	39
1 Module 12 MET	20	5
Sub-total:	1185	1089
Sub-zones III and IV		
1 Module 3 radar	400	400
2 Module 1 radar	620	620
1 Module 13 MET	40	5
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
3 Module 10 VHF	57	39
1 Module 15 HYD	50	5
Sub-total:	1235	1089
Sub-zones V, VI, VII, and VIII		
4 Module 1 radars	1240	1240
1 Module 13 MET	40	5
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
4 Module 10 VHF	76	52
Sub-total:	1444	1322
TOTAL HARDWARE COSTS:	8264	5500

Puget Sound (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 Non-recurring

Hardware	$8264
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required, existing radars used	4132
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no problem	1653
Spares & Training (10%)	826
Civil Engineering Assumptions: Building modification at West Point, land acquisition	1000
PROJECT ESTIMATE:	15875
Data Base Management System	300
TOTAL: (non-recurring)	$16175

2.2 Recurring (10 year)

Hardware	5500
3 Watchstanders x 5 = 15 man/years @ 50K x 10	7500
1 Watch Supervisor	500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$14500
TOTAL 10-YEAR PROJECT COST:	$30675

2.3 Non-government Costs

ADS Hardware for ferries (35 vessels)	$70	$35

Comments:

1. Costs do not include any existing USCG hardware, however, the existing radar sites/buildings are used.

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix B Zone 2 Puget Sound, WA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 201A		
4706	A	NEAH BAY, WASH.
4708	A	PORT ANGELES HARBOR, WASH.
4710	A	PORT TOWNSEND HARBOR, WASH.
4712	A	WATERWAY CONNECTING PORT TOWNSEND BAY AND OAK BAY, WASH.
4714	A	PORT GAMBLE HARBOR, WASH.
4716	A	HAMMERSLEY INLET, WASH.
4718	A	OLYMPIA HARBOR, WASH.
4720	A	TACOMA HARBOR, WASH.
4722	A	SEATTLE HARBOR, WASH.
4725	A	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4728	A	SWINOMISH CHANNEL, WASH.
4730	A	ANACORTES HARBOR, WASH.
4732	A	BELLINGHAM BAY AND HARBOR, WASH.
4742	A	SKAGIT RIVER, WASH.
4744	A	BLAINE HARBOR, WASH.
9001	A	
Subzone 202B		
4710	A	PORT TOWNSEND HARBOR, WASH.
4710	B	PORT TOWNSEND HARBOR, WASH.
4712	A	WATERWAY CONNECTING PORT TOWNSEND BAY AND OAK BAY, WASH.
4712	B	WATERWAY CONNECTING PORT TOWNSEND BAY AND OAK BAY, WASH.
4714	A	PORT GAMBLE HARBOR, WASH.
4714	B	PORT GAMBLE HARBOR, WASH.
4716	A	HAMMERSLEY INLET, WASH.
4716	B	HAMMERSLEY INLET, WASH.
4718	A	OLYMPIA HARBOR, WASH.
4718	B	OLYMPIA HARBOR, WASH.
4720	A	TACOMA HARBOR, WASH.
4720	B	TACOMA HARBOR, WASH.
4722	A	SEATTLE HARBOR, WASH.
4722	B	SEATTLE HARBOR, WASH.
4725	A	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4725	B	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4728	A	SWINOMISH CHANNEL, WASH.
4728	B	SWINOMISH CHANNEL, WASH.
4730	A	ANACORTES HARBOR, WASH.
4730	B	ANACORTES HARBOR, WASH.
4732	A	BELLINGHAM BAY AND HARBOR, WASH.
4732	B	BELLINGHAM BAY AND HARBOR, WASH.
4742	A	SKAGIT RIVER, WASH.
4742	B	SKAGIT RIVER, WASH.
4744	A	BLAINE HARBOR, WASH.
4744	B	BLAINE HARBOR, WASH.
9001	A	
9001	B	
Subzone 203C		
4712	A	WATERWAY CONNECTING PORT TOWNSEND BAY AND OAK BAY, WASH.
4712	B	WATERWAY CONNECTING PORT TOWNSEND BAY AND OAK BAY, WASH.
4714	A	PORT GAMBLE HARBOR, WASH.
4714	B	PORT GAMBLE HARBOR, WASH.
4716	A	HAMMERSLEY INLET, WASH.
4716	B	HAMMERSLEY INLET, WASH.

Appendix B Zone 2 Puget Sound, WA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 203C		
4718	A	OLYMPIA HARBOR, WASH.
4718	B	OLYMPIA HARBOR, WASH.
4720	A	TACOMA HARBOR, WASH.
4720	B	TACOMA HARBOR, WASH.
4722	A	SEATTLE HARBOR, WASH.
4722	B	SEATTLE HARBOR, WASH.
4725	A	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4725	B	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4728	A	SWINOMISH CHANNEL, WASH.
4728	B	SWINOMISH CHANNEL, WASH.
4742	A	SKAGIT RIVER, WASH.
4742	B	SKAGIT RIVER, WASH.
Subzone 204E		
4730	A	ANACORTES HARBOR, WASH.
4730	B	ANACORTES HARBOR, WASH.
4732	A	BELLINGHAM BAY AND HARBOR, WASH.
4732	B	BELLINGHAM BAY AND HARBOR, WASH.
4744	A	BLAINE HARBOR, WASH.
4744	B	BLAINE HARBOR, WASH.
Subzone 205C		
4744	A	BLAINE HARBOR, WASH.
4744	B	BLAINE HARBOR, WASH.
9001	A	
9001	B	
Subzone 206D		
4725	A	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
4725	B	EVERETT HARBOR AND SNOHOMISH RIVER, WASH.
Subzone 209E		
4716	A	HAMMERSLEY INLET, WASH.
4716	B	HAMMERSLEY INLET, WASH.
4718	A	OLYMPIA HARBOR, WASH.
4718	B	OLYMPIA HARBOR, WASH.
Subzone 210D		
4720	A	TACOMA HARBOR, WASH.
4720	B	TACOMA HARBOR, WASH.

Appendix B Zone 2 Puget Sound, WA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 201A STRAIT OF JUAN DE FUCA

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,905,257	0	0	0	4,905,257
2	FOREST PRODUCTS	131,306	0	0	0	131,306
3	FISHERIES PRODUCTS	149,686	0	0	0	149,686
4	MININC PRODUCTS, NEC	3,835,112	0	2,500,100	0	6,335,212
5	PROC. FOODS & MFTRS, NEC	22,952,220	0	2,566,647	0	25,518,867
6	WASTE OF MANUFACTURING	850,086	0	650,958	0	1,501,043
1311	CRUDE PETROLEUM	0	11,040,962	0	0	11,040,962
1492	SULPHUR, DRY	283	0	0	0	283
2810	SODIUM HYDROXIDE (CAUSTI	183,769	0	153,083	0	336,851
2811	CRUDE PROD-COAL TAR-PET	17,776	0	0	0	17,776
2813	ALCOHOLS	0	26,318	0	0	26,318
2817	BENZENE AND TOLUENE	0	10,548	0	0	10,548
2818	SULPHURIC ACID	0	9,245	0	0	9,245
2871	NITROGEN CHEM FERTILIZER	1	15,423	0	0	15,424
2872	POTASSIC CHEM FERTILIZER	305	0	0	0	305
2911	GASOLINE, INCL NATURAL	0	1,592,156	0	314,062	1,906,218
2912	JET FUEL	0	320,797	0	119,467	440,263
2913	KEROSENE	0	3,426	0	0	3,426
2914	DISTILLATE FUEL OIL	0	897,578	0	397,267	1,294,845
2915	RESIDUAL FUEL OIL	0	1,366,814	0	2,441,446	3,808,260
2916	LUBRIC OILS-GREASES	0	52,755	0	1,682	54,438
2917	NAPHTHA, PETRLM SOLVENTS	0	73,600	0	0	73,600
2921	LIQUI PETR-COAL-NATR GAS	14,198	6,402	0	191	20,791
	Subzone Total :	33,039,998	15,416,024	5,870,787	3,274,115	57,600,925

Subzone 202B TOP OF PUGET SOUND

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,901,955	0	0	0	4,901,955
2	FOREST PRODUCTS	131,303	0	0	0	131,303
3	FISHERIES PRODUCTS	149,625	0	0	0	149,625
4	MINING PRODUCTS, NEC	3,832,811	0	2,500,100	0	6,332,911
5	PROC. FOODS & MFTRS, NEC	21,009,598	0	2,332,748	0	23,342,346
6	WASTE OF MANUFACTURING	850,027	0	650,958	0	1,500,984
1311	CRUDE PETROLEUM	0	11,040,368	0	0	11,040,368
1492	SULPHUR, DRY	283	0	0	0	283
2810	SODIUM HYDROXIDE (CAUSTI	183,769	0	115,164	0	298,932
2811	CRUDE PROD-COAL TAR-PET	17,776	0	0	0	17,776
2813	ALCOHOLS	0	26,318	0	0	26,318
2817	BENZENE AND TOLUENE	0	10,548	0	0	10,548
2818	SULPHURIC ACID	0	9,245	0	0	9,245
2871	NITROGEN CHEM FERTILIZER	1	13,177	0	0	13,178
2872	POTASSIC CHEM FERTILIZER	305	0	0	0	305
2911	GASOLINE, INCL NATURAL	0	1,571,382	0	307,018	1,878,400
2912	JET FUEL	0	320,797	0	119,467	440,263
2913	KEROSENE	0	3,426	0	0	3,426
2914	DISTILLATE FUEL OIL	0	882,655	0	383,936	1,266,591
2915	RESIDUAL FUEL OIL	0	1,275,174	0	2,158,046	3,433,220
2916	LUBRIC OILS-GREASES	0	52,712	0	1,564	54,277
2917	NAPHTHA, PETRLM SOLVENTS	0	73,600	0	0	73,600
2921	LIQUI PETR-COAL-NATR GAS	14,198	6,402	0	191	20,791
	Subzone Total :	31,091,650	15,285,804	5,598,969	2,970,222	54,946,646

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 203C MAJORITY OF PUGET SOUND

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,719,907	0	0	0	4,719,907
2	FOREST PRODUCTS	127,881	0	0	0	127,881
3	FISHERIES PRODUCTS	131,733	0	0	0	131,733
4	MINING PRODUCTS, NEC	3,196,975	0	2,431,279	0	5,628,254
5	PROC. FOODS & MFTRS, NEC	18,708,650	0	1,566,838	0	20,275,488
6	WASTE OF MANUFACTURING	794,814	0	410,439	0	1,205,253
1311	CRUDE PETROLEUM	0	1,713,061	0	0	1,713,061
1492	SULPHUR, DRY	277	0	0	0	277
2810	SODIUM HYDROXIDE (CAUSTI	68,540	0	112,192	0	180,732
2811	CRUDE PROD-COAL TAR-PET	17,317	0	0	0	17,317
2813	ALCOHOLS	0	23,619	0	0	23,619
2817	BENZENE AND TOLUENE	0	5,954	0	0	5,954
2818	SULPHURIC ACID	0	164	0	0	164
2871	NITROGEN CHEM FERTILIZER	1	12,837	0	0	12,838
2872	POTASSIC CHEM FERTILIZER	297	0	0	0	297
2911	GASOLINE, INCL NATURAL	0	666,835	0	251,846	918,681
2912	JET FUEL	0	69,897	0	90,165	160,062
2913	KEROSENE	0	3,338	0	0	3,338
2914	DISTILLATE FUEL OIL	0	335,022	0	290,877	625,899
2915	RESIDUAL FUEL OIL	0	214,188	0	1,887,623	2,101,811
2916	LUBRIC OILS-GREASES	0	48,185	0	1,362	49,547
2917	NAPHTHA, PETRLM SOLVENTS	0	1,510	0	0	1,510
2921	LIQUI PETR-COAL-NATR GAS	80	6,237	0	0	6,317
	Subzone Total :	27,766,472	3,100,847	4,520,748	2,521,873	37,909,940

Subzone 204E ANACORTES AREA AND ISLANDS

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	55,327	0	0	0	55,327
3	FISHERIES PRODUCTS	14,031	0	0	0	14,031
4	MINING PRODUCTS, NEC	516,377	0	2,910	0	519,287
5	PROC. FOODS & MFTRS, NEC	1,555,947	0	475,920	0	2,031,867
6	WASTE OF MANUFACTURING	5,404	0	223,722	0	229,126
1311	CRUDE PETROLEUM	0	9,042,429	0	0	9,042,429
2810	SODIUM HYDROXIDE (CAUSTI	110,487	0	0	0	110,487
2813	ALCOHOLS	0	2,020	0	0	2,020
2817	BENZENE AND TOLUENE	0	4,323	0	0	4,323
2818	SULPHURIC ACID	0	8,843	0	0	8,843
2911	GASOLINE, INCL NATURAL	0	864,000	0	45,308	909,308
2912	JET FUEL	0	242,622	0	26,219	268,841
2914	DISTILLATE FUEL OIL	0	524,858	0	79,131	603,989
2915	RESIDUAL FUEL OIL	0	1,028,082	0	212,625	1,240,707
2916	LUBRIC OILS-GREASES	0	3,150	0	144	3,294
2917	NAPHTHA, PETRLM SOLVENTS	0	70,191	0	0	70,191
2921	LIQUI PETR-COAL-NATR GAS	13,752	0	0	186	13,938
	Subzone Total :	2,271,325	11,790,518	702,552	363,613	15,128,008

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 205C BELLINGHAM AREA

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	126,487	0	0	0	126,487
2	FOREST PRODUCTS	3,388	0	0	0	3,388
3	FISHERIES PRODUCTS	3,861	0	0	0	3,861
4	MINING PRODUCTS, NEC	98,899	0	64,511	0	163,410
5	PROC. FOODS & MFTRS, NEC	542,118	0	60,193	0	602,311
6	WASTE OF MANUFACTURING	21,934	0	16,797	0	38,730
1311	CRUDE PETROLEUM	0	284,878	0	0	284,878
1492	SULPHUR, DRY	6	0	0	0	6
2810	SODIUM HYDROXIDE (CAUSTI	4,742	0	2,972	0	7,713
2811	CRUDE PROD-COAL TAR-PET	459	0	0	0	459
2813	ALCOHOLS	0	679	0	0	679
2817	BENZENE AND TOLUENE	0	271	0	0	271
2818	SULPHURIC ACID	0	238	0	0	238
2871	NITROGEN CHEM FERTILIZER	0	340	0	0	340
2872	POTASSIC CHEM FERTILIZER	8	0	0	0	8
2911	GASOLINE, INCL NATURAL	0	40,547	0	7,922	48,469
2912	JET FUEL	0	8,278	0	3,083	11,360
2913	KEROSENE	0	88	0	0	88
2914	DISTILLATE FUEL OIL	0	22,775	0	9,907	32,682
2915	RESIDUAL FUEL OIL	0	32,904	0	55,685	88,589
2916	LUBRIC OILS-GREASES	0	1,359	0	40	1,400
2917	NAPHTHA, PETRLM SOLVENTS	0	1,899	0	0	1,899
2921	LIQUI PETR-COAL-NATR GAS	366	165	0	5	536
	Subzone Total :	802,267	394,421	144,472	76,642	1,417,803

Subzone 206D EVERETT HARBOR

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	10,094	0	0	0	10,094
2	FOREST PRODUCTS	5	0	0	0	5
3	FISHERIES PRODUCTS	219	0	0	0	219
4	MINING PRODUCTS, NEC	393,802	0	34,959	0	428,761
5	PROC. FOODS & MFTRS, NEC	2,121,138	0	95,020	0	2,216,158
6	WASTE OF MANUFACTURING	1,969	0	4,872	0	6,841
2810	SODIUM HYDROXIDE (CAUSTI	0	0	12,350	0	12,350
2911	GASOLINE, INCL NATURAL	0	9,384	0	0	9,384
2912	JET FUEL	0	3,638	0	0	3,638
2914	DISTILLATE FUEL OIL	0	0	0	2,243	2,243
2915	RESIDUAL FUEL OIL	0	4,236	0	34,993	39,229
2916	LUBRIC OILS-GREASES	0	25	0	73	98
	Subzone Total :	2,527,227	17,283	147,201	37,309	2,729,020

Subzone 209E OLYMPIA, WASHINGTON

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
2	FOREST PRODUCTS	13,957	0	0	0	13,957
5	PROC. FOODS & MFTRS, NEC	431,691	0	149,959	0	581,650
6	WASTE OF MANUFACTURING	0	0	37,000	0	37,000
2914	DISTILLATE FUEL OIL	0	0	0	792	792
2915	RESIDUAL FUEL OIL	0	0	0	8,535	8,535
	Subzone Total :	445,648	0	186,959	9,327	641,934

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 210D TACOMA, WASHINGTO AREA

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,580,588	0	0	0	2,580,588
2	FOREST PRODUCTS	110,590	0	0	0	110,590
3	FISHERIES PRODUCTS	35,469	0	0	0	35,469
4	MINING PRODUCTS, NEC	1,760,816	0	438,891	0	2,199,707
5	PROC. FOODS & MFTRS, NEC	7,584,934	0	352,808	0	7,937,742
6	WASTE OF MANUFACTURING	408,436	0	36,258	0	444,694
1311	CRUDE PETROLEUM	0	1,670,157	0	0	1,670,157
1492	SULPHUR, DRY	237	0	0	0	237
2810	SODIUM HYDROXIDE (CAUSTI	68,162	0	58,565	0	126,727
2811	CRUDE PROD-COAL TAR-PET	3,230	0	0	0	3,230
2813	ALCOHOLS	0	20,177	0	0	20,177
2817	BENZENE AND TOLUENE	0	5,463	0	0	5,463
2871	NITROGEN CHEM FERTILIZER	0	331	0	0	331
2872	POTASSIC CHEM FERTILIZER	42	0	0	0	42
2911	GASOLINE, INCL NATURAL	0	137,019	0	17,777	154,796
2912	JET FUEL	0	13,261	0	20,695	33,956
2914	DISTILLATE FUEL OIL	0	71,485	0	60,371	131,856
2915	RESIDUAL FUEL OIL	0	133,172	0	688,688	821,860
2916	LUBRIC OILS-GREASES	0	10,522	0	355	10,877
2917	NAPHTHA, PETRLM SOLVENTS	0	2	0	0	2
2921	LIQUI PETR-COAL-NATR GAS	0	392	0	0	392
	Subzone Total :	12,552,504	2,061,981	886,522	787,886	16,288,893

Appendix B ZONE 2 Puget Sound, WA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 201A				
Passenger	0	116	3,772	3,888
Dry Cargo	860	3,542	98,406	102,808
Tanker	383	498	175	1,056
Dry Cargo Barge Tow	79	0	717	796
Tanker Barge Tow	18	0	539	557
Tug/Tow Boat	12	0	4,843	4,855
Subzone Total:	1,352	4,156	108,452	113,960
Subzone : 202B				
Passenger	0	116	18,264	13,380
Dry Cargo	860	3,320	284,129	288,309
Tanker	383	457	169	1,009
Dry Cargo Barge Tow	70	0	12,504	12,574
Tanker Barge Tow	18	0	6,526	6,544
Tug/Tow Boat	8	0	51,447	51,455
Subzone Total:	1,339	3,893	373,039	378,271
Subzone : 203C				
Passenger	0	116	227,405	227,521
Dry Cargo	851	3,191	160,796	164,838
Tanker	112	250	94	456
Dry Cargo Barge Tow	57	0	10,883	10,940
Tanker Barge Tow	13	0	5,849	5,862
Tug/Tow Boat	7	0	45,326	45,333
Subzone Total:	1,040	3,557	450,353	454,950
Subzone : 204E				
Passenger	0	0	41,632	41,632
Dry Cargo	9	129	121,423	121,561
Tanker	271	207	73	551
Dry Cargo Barge Tow	13	0	815	828
Tanker Barge Tow	5	0	581	586
Tug/Tow Boat	1	0	5,703	5,704
Subzone Total:	299	336	170,227	170,862

Appendix B ZONE 2 Puget Sound, WA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 205C				
Passenger	0	0	2,110	2,110
Dry Cargo	0	0	39,998	39,998
Tug/Tow Boat	0	0	4	4
Subzone Total:	0	0	42,112	42,112
Subzone : 206D				
Passenger	0	0	732	732
Dry Cargo	60	167	9,423	9,650
Tanker	0	3	0	3
Dry Cargo Barge Tow	0	0	508	508
Tanker Barge Tow	0	0	270	270
Tug/Tow Boat	1	0	5,068	5,069
Subzone Total:	61	170	16,001	16,232
Subzone : 207D				
Passenger	0	0	58,711	58,711
Subzone Total:	0	0	58,711	58,711
Subzone : 208E				
Passenger	0	0	21,576	21,576
Subzone Total:	0	0	21,576	21,576
Subzone : 209E				
Passenger	0	0	25,950	25,950
Dry Cargo	0	77	14,671	14,748
Dry Cargo Barge Tow	0	0	455	455
Tanker Barge Tow	0	0	23	23
Tug/Tow Boat	0	0	1,372	1,372
Subzone Total:	0	77	42,471	42,548
Subzone : 210D				
Dry Cargo	342	1,466	32,690	34,498
Tanker	59	149	61	269
Dry Cargo Barge Tow	19	0	2,828	2,847
Tanker Barge Tow	5	0	1,985	1,990
Tug/Tow Boat	0	0	19,496	19,496
Subzone Total:	425	1,615	57,060	59,100

Note: Sum of all vessel transits within each study subzone.

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Appendix B ZONE 2 Puget Sound, WA

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 2 Puget Sound, WA

Vessel Type	Large	Medium	Small	Total
Passenger	0	116	269,933	270,049
Dry Cargo	860	3,542	325,709	330,111
Tanker	383	498	175	1,056
Dry Cargo Barge Tow	79	0	13,221	13,300
Tanker Barge Tow	18	0	7,065	7,083
Tug/Tow Boat	12	0	56,290	56,302
Zone Total:	1,352	4,156	672,393	677,901

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix B Zone 2 Puget Sound, WA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix B Zone 2 Puget Sound, WA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
201A	STRAIT OF JUAN DE FUCA	2,397	.53
202B	TOP OF PUGET SOUND	5,321	10.15
203C	MAJORITY OF PUGET SOUND	39,777	53.90
204E	ANACORTES AREA AND ISLANDS	8,427	17.16
205C	BELLINGHAM AREA	4,081	7.86
206D	EVERETT HARBOR	11,191	104.59
207D	SEATTLE, WASHINGTON	13,185	2,690.82
208E	BREMERTON, WASHINGTON AREA	3,457	64.02
209E	OLYMPIA, WASHINGTON	31,796	181.69
210D	TACOMA, WASHINGTO AREA	23,278	4,750.61
	Total for Zone	142,910	20.03

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix B ZONE 2 Puget Sound, WA 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 201A				
Passenger	0	13	3,959	3,971
Dry Cargo	1,148	4,663	400,206	406,017
Tanker	415	566	196	1,177
Dry Cargo Tow	0	0	15,494	15,494
Tanker Tow	0	0	7,910	7,910
Tug/Tow Boat	0	0	65,529	65,529
Subzone Total:	1,563	5,242	493,294	500,098
Subzone : 202B				
Passenger	0	13	19,058	19,071
Dry Cargo	1,148	4,403	350,788	356,339
Tanker	415	519	189	1,123
Dry Cargo Tow	0	0	14,632	14,632
Tanker Tow	0	0	7,306	7,306
Tug/Tow Boat	0	0	59,824	59,824
Subzone Total:	1,563	4,935	451,797	458,295
Subzone : 203C				
Passenger	0	13	238,667	238,680
Dry Cargo	1,136	4,243	205,815	211,194
Tanker	120	277	104	501
Dry Cargo Tow	0	0	13,680	13,680
Tanker Tow	0	0	6,658	6,658
Tug/Tow Boat	0	0	53,236	53,236
Subzone Total:	1,256	4,533	518,160	523,949
Subzone : 204E				
Passenger	0	0	43,582	43,582
Dry Cargo	12	160	144,973	145,145
Tanker	295	242	85	622
Dry Cargo Tow	0	0	952	952
Tanker Tow	0	0	648	648
Tug/Tow Boat	0	0	6,588	6,588
Subzone Total:	307	402	196,828	197,537

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 205C				
Passenger	0	0	2,214	2,214
Dry Cargo	0	0	44,086	44,086
Tug/Tow Boat	0	0	4	4
Subzone Total:	0	0	46,304	46,304
Subzone : 206D				
Passenger	0	0	768	768
Dry Cargo	82	217	12,313	12,612
Tanker	0	4	0	4
Dry Cargo Tow	0	0	595	595
Tanker Tow	0	0	300	300
Tug/Tow Boat	0	0	5,825	5,825
Subzone Total:	82	221	19,801	20,104
Subzone : 207D				
Passenger	0	13	61,740	61,753
Dry Cargo	594	2,060	115,846	118,500
Tanker	56	107	36	199
Dry Cargo Tow	0	0	7,306	7,306
Tanker Tow	0	0	3,994	3,994
Tug/Tow Boat	0	0	20,886	20,886
Subzone Total:	650	2,180	209,808	212,638
Subzone : 208E				
Passenger	0	0	25,126	25,126
Subzone Total:	0	0	25,126	25,126
Subzone : 209E				
Passenger	0	0	27,233	27,233
Dry Cargo	0	98	17,696	17,794
Dry Cargo Tow	0	0	518	518
Tanker Tow	0	0	26	26
Tug/Tow Boat	0	0	1,338	1,338
Subzone Total:	0	98	46,811	46,909

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 210D				
Dry Cargo	460	1,868	41,843	44,171
Tanker	64	166	66	296
Dry Cargo Tow	0	0	3,311	3,311
Tanker Tow	0	0	2,224	2,224
Tug/Tow Boat	0	0	22,968	22,968
Subzone Total:	524	2,034	70,412	72,970

Note: Sum of all vessel transits within each study subzone.

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 201A				
Passenger	0	13	4,154	4,167
Dry Cargo	1,383	5,508	457,932	464,823
Tanker	441	626	221	1,288
Dry Cargo Tow	0	0	17,106	17,106
Tanker Tow	0	0	8,481	8,481
Tug/Tow Boat	0	0	72,642	72,642
Subzone Total:	1,824	6,147	560,536	568,507
Subzone : 202B				
Passenger	0	13	20,000	20,014
Dry Cargo	1,383	5,214	402,975	409,572
Tanker	441	575	213	1,229
Dry Cargo Tow	0	0	16,138	16,138
Tanker Tow	0	0	7,833	7,833
Tug/Tow Boat	0	0	66,320	66,320
Subzone Total:	1,824	5,802	513,479	521,106
Subzone : 203C				
Passenger	0	13	250,469	250,482
Dry Cargo	1,369	5,028	240,299	246,696
Tanker	126	300	113	539
Dry Cargo Tow	0	0	15,089	15,089
Tanker Tow	0	0	7,140	7,140
Tug/Tow Boat	0	0	59,013	59,013
Subzone Total:	1,495	5,341	572,123	578,959
Subzone : 204E				
Passenger	0	0	45,737	45,737
Dry Cargo	14	186	162,676	162,876
Tanker	315	275	100	690
Dry Cargo Tow	0	0	1,049	1,049
Tanker Tow	0	0	693	693
Tug/Tow Boat	0	0	7,307	7,307
Subzone Total:	329	461	217,562	218,352

Appendix B ZONE 2 Puget Sound, WA 7/24/91

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 205C				
Passenger	0	0	2,324	2,324
Dry Cargo	0	0	46,070	46,070
Tug/Tow Boat	0	0	5	5
Subzone Total:	0	0	48,399	48,399
Subzone : 206D				
Passenger	0	0	806	806
Dry Cargo	100	259	14,762	15,121
Tanker	0	4	0	4
Dry Cargo Tow	0	0	658	658
Tanker Tow	0	0	318	318
Tug/Tow Boat	0	0	6,461	6,461
Subzone Total:	100	263	23,005	23,368
Subzone : 207D				
Passenger	0	13	64,793	64,806
Dry Cargo	714	2,457	137,516	140,687
Tanker	58	116	40	214
Dry Cargo Tow	0	0	8,056	8,056
Tanker Tow	0	0	4,288	4,288
Tug/Tow Boat	0	0	23,140	23,140
Subzone Total:	772	2,586	237,833	241,191
Subzone : 208E				
Passenger	0	0	26,368	26,368
Subzone Total:	0	0	26,368	26,368
Subzone : 209E				
Passenger	0	0	28,580	28,580
Dry Cargo	0	114	19,854	19,968
Dry Cargo Tow	0	0	557	557
Tanker Tow	0	0	27	27
Tug/Tow Boat	0	0	1,487	1,487
Subzone Total:	0	114	50,505	50,619

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 210D				
Dry Cargo	555	2,198	49,244	51,997
Tanker	68	180	71	319
Dry Cargo Tow	0	0	3,655	3,655
Tanker Tow	0	0	2,387	2,387
Tug/Tow Boat	0	0	25,446	25,446
Subzone Total:	623	2,378	80,803	83,804

Note: Sum of all vessel transits within each study subzone.

Appendix B ZONE 2 Puget Sound, WA 7/24/91

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 201A				
Passenger	0	14	4,293	4,307
Dry Cargo	1,677	6,560	527,400	535,637
Tanker	469	694	250	1,413
Dry Cargo Tow	0	0	18,889	18,889
Tanker Tow	0	0	9,092	9,092
Tug/Tow Boat	0	0	80,524	80,524
Subzone Total:	2,146	7,268	640,448	649,862
Subzone : 202B				
Passenger	0	14	20,669	20,683
Dry Cargo	1,677	6,223	466,050	473,950
Tanker	469	638	242	1,349
Dry Cargo Tow	0	0	17,801	17,801
Tanker Tow	0	0	8,396	8,396
Tug/Tow Boat	0	0	73,521	73,521
Subzone Total:	2,146	6,875	586,679	595,700
Subzone : 203C				
Passenger	0	14	258,844	258,858
Dry Cargo	1,661	6,005	282,565	290,231
Tanker	133	325	123	581
Dry Cargo Tow	0	0	16,645	16,645
Tanker Tow	0	0	7,657	7,657
Tug/Tow Boat	0	0	65,417	65,417
Subzone Total:	1,794	6,344	631,251	639,389
Subzone : 204E				
Passenger	0	0	47,266	47,266
Dry Cargo	16	218	183,485	183,719
Tanker	336	313	119	768
Dry Cargo Tow	0	0	1,156	1,156
Tanker Tow	0	0	739	739
Tug/Tow Boat	0	0	8,104	8,104
Subzone Total:	352	531	240,869	241,752

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 205C				
Passenger	0	0	2,402	2,402
Dry Cargo	0	0	47,838	47,838
Tug/Tow Boat	0	0	5	5
Subzone Total:	0	0	50,245	50,245
Subzone : 206D				
Passenger	0	0	833	833
Dry Cargo	122	312	17,820	18,254
Tanker	0	4	0	4
Dry Cargo Tow	0	0	726	726
Tanker Tow	0	0	336	336
Tug/Tow Boat	0	0	7,170	7,170
Subzone Total:	122	316	26,885	27,323
Subzone : 207D				
Passenger	0	14	66,960	66,974
Dry Cargo	865	2,956	164,367	168,188
Tanker	60	124	43	227
Dry Cargo Tow	0	0	8,885	8,885
Tanker Tow	0	0	4,603	4,603
Tug/Tow Boat	0	0	25,636	25,636
Subzone Total:	925	3,094	270,494	274,513
Subzone : 208E				
Passenger	0	0	27,250	27,250
Subzone Total:	0	0	27,250	27,250
Subzone : 209E				
Passenger	0	0	29,536	29,536
Dry Cargo	0	133	22,345	22,478
Dry Cargo Tow	0	0	599	599
Tanker Tow	0	0	29	29
Tug/Tow Boat	0	0	1,653	1,653
Subzone Total:	0	133	54,162	54,295

Appendix B ZONE 2 Puget Sound, WA

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TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 210D				
Dry Cargo	674	2,604	58,331	61,609
Tanker	73	197	77	347
Dry Cargo Tow	0	0	4,033	4,033
Tanker Tow	0	0	2,563	2,563
Tug/Tow Boat	0	0	28,191	28,191
Subzone Total:	747	2,801	93,195	96,743

Note: Sum of all vessel transits within each study subzone.

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 201A				
Passenger	0	14	4,437	4,451
Dry Cargo	2,043	7,869	611,397	621,309
Tanker	496	781	291	1,568
Dry Cargo Tow	0	0	20,859	20,859
Tanker Tow	0	0	9,745	9,745
Tug/Tow Boat	0	0	89,261	89,261
Subzone Total:	2,539	8,664	735,990	747,193
Subzone : 202B				
Passenger	0	14	21,360	21,374
Dry Cargo	2,043	7,477	542,567	552,087
Tanker	496	720	282	1,498
Dry Cargo Tow	0	0	19,636	19,636
Tanker Tow	0	0	8,998	8,998
Tug/Tow Boat	0	0	81,503	81,503
Subzone Total:	2,539	8,211	674,346	685,096
Subzone : 203C				
Passenger	0	14	267,500	267,514
Dry Cargo	2,024	7,221	334,466	343,711
Tanker	139	355	134	628
Dry Cargo Tow	0	0	18,361	18,361
Tanker Tow	0	0	8,211	8,211
Tug/Tow Boat	0	0	72,515	72,515
Subzone Total:	2,163	7,590	701,187	710,940
Subzone : 204E				
Passenger	0	0	48,847	48,847
Dry Cargo	19	256	208,101	208,376
Tanker	357	365	148	870
Dry Cargo Tow	0	0	1,275	1,275
Tanker Tow	0	0	787	787
Tug/Tow Boat	0	0	8,988	8,988
Subzone Total:	376	621	268,146	269,143

Appendix B ZONE 2 Puget Sound, WA 7/24/91

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 205C				
Passenger	0	0	2,482	2,482
Dry Cargo	0	0	49,402	49,402
Tug/Tow Boat	0	0	5	5
Subzone Total:	0	0	51,889	51,889
Subzone : 206D				
Passenger	0	0	861	861
Dry Cargo	148	377	21,581	22,106
Tanker	0	5	0	5
Dry Cargo Tow	0	0	802	802
Tanker Tow	0	0	354	354
Tug/Tow Boat	0	0	7,955	7,955
Subzone Total:	148	382	31,553	32,083
Subzone : 207D				
Passenger	0	14	69,199	69,213
Dry Cargo	1,055	3,584	197,688	202,327
Tanker	62	134	48	244
Dry Cargo Tow	0	0	9,800	9,800
Tanker Tow	0	0	4,942	4,942
Tug/Tow Boat	0	0	28,401	28,401
Subzone Total:	1,117	3,732	310,078	314,927
Subzone : 208E				
Passenger	0	0	28,161	28,161
Subzone Total:	0	0	28,161	28,161
Subzone : 209E				
Passenger	0	0	30,523	30,523
Dry Cargo	0	156	25,251	25,407
Dry Cargo Tow	0	0	642	642
Tanker Tow	0	0	30	30
Tug/Tow Boat	0	0	1,840	1,840
Subzone Total:	0	156	58,286	58,442

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Appendix B ZONE 2 Puget Sound, WA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 210D				
Dry Cargo	821	3,104	69,476	73,401
Tanker	77	216	83	376
Dry Cargo Tow	0	0	4,451	4,451
Tanker Tow	0	0	2,752	2,752
Tug/Tow Boat	0	0	31,232	31,232
Subzone Total:	898	3,320	107,994	112,212

Note: Sum of all vessel transits within each study subzone.

Appendix B ZONE 2 Puget Sound, WA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	122	283,281	283,403
Dry Cargo	1,038	4,221	374,024	379,283
Tanker	415	566	196	1,177
Dry Cargo Tow	0	0	15,494	15,494
Tanker Tow	0	0	7,910	7,910
Tug/Tow Boat	0	0	65,529	65,529
1995 Zone Total:	1,453	4,909	746,434	752,796
2000 FORECASTED ZONE TOTALS				
Passenger	0	128	297,289	297,417
Dry Cargo	1,174	4,685	409,465	415,324
Tanker	441	626	221	1,288
Dry Cargo Tow	0	0	17,106	17,106
Tanker Tow	0	0	8,481	8,481
Tug/Tow Boat	0	0	72,642	72,642
2000 Zone Total:	1,615	5,439	805,204	812,258
2005 FORECASTED ZONE TOTALS				
Passenger	0	132	307,230	307,362
Dry Cargo	1,424	5,403	459,420	466,247
Tanker	469	694	250	1,413
Dry Cargo Tow	0	0	18,889	18,889
Tanker Tow	0	0	9,092	9,092
Tug/Tow Boat	0	0	80,524	80,524
2005 Zone Total:	1,893	6,229	875,405	883,527
2010 FORECASTED ZONE TOTALS				
Passenger	0	136	317,504	317,640
Dry Cargo	1,735	6,480	530,288	538,503
Tanker	496	781	291	1,568
Dry Cargo Tow	0	0	20,859	20,859
Tanker Tow	0	0	9,745	9,745
Tug/Tow Boat	0	0	89,261	89,261
2010 Zone Total:	2,231	7,397	967,948	977,576

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 201A STRAIT OF JUAN DE FUCA						
Dry Cargo	Large	0	2	0	0	2
Tanker	Medium	0	0	1	0	1
Subzone Totals:		0	2	1	0	3
Subzone: 202B TOP OF PUGET SOUND						
Dry Cargo	Large	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 203C MAJORITY OF PUGET SOUND						
Passenger	Medium	0	0	1	0	1
Passenger	Small	0	0	1	0	1
Dry Cargo	Large	0	0	1	0	1
Dry Cargo	Small	0	0	1	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		2	0	4	0	6
Subzone: 204E ANACORTES AREA AND ISLANDS						
Passenger	Medium	0	0	3	0	3
Passenger	Small	0	0	2	0	2
Fishing	Small	2	0	0	0	2
Subzone Totals:		2	0	5	0	7
Subzone: 206D EVERETT HARBOR						
Dry Cargo	Large	0	0	1	0	1
Tug/Tow Boat	Small	1	0	0	0	1
Other	Small	1	0	0	0	1
Subzone Totals:		2	0	1	0	3

Note: OTHER equals barge breakaways and weather caused vessel casualties.

Appendix B Zone 2 Puget Sound, WA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 207D SEATTLE, WASHINGTON						
Passenger	Small	1	0	0	0	1
Dry Cargo	Large	2	0	0	0	2
Tanker Barge Tow	Small	1	0	0	0	1
Subzone Totals:		4	0	0	0	4
Subzone: 209E OLYMPIA, WASHINGTON						
Dry Cargo	Large	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Zone Totals:		10	2	13	0	25

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE B-8 ZONE 2, PUGET SOUND, WA - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0201A	I	I	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0202B	I	I	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0203C	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0204E	I	I	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0205C	I	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0206D	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	III
0207D	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	II	III
0208E	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
0209E	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
0210D	I	I	I	I	I	I	I	I	I	I	I	I	I	II	II	II	III

LEGEND

VTS Level I -
A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -
The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -
This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

APPENDIX TABLE B-9 ZONE 2, PUGET SOUND, WA - CANDIDATE VTS DESIGN - 1995-2010

UNITS	Module	Description
8	Radar Module 1	Average Performance
0	Radar Module 2	Average Performance
2	Radar Module 3	High Performance
0	Radar Module 4	High Performance
0	Radar Module 5	Special Purpose
0	Radar Module 6	Special Purpose
0	ADS Module 7	Active Radar Transponder (Type 1)
0	ADS Module 8	Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	Positional Transponder, Small Area, High Accuracy (Type 6)
10	VHF Module 10	Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	High power VHF Transmitting/ Receiving Facility
2	Meteorological Module 12	Air temperature, wind direction and speed
4	Meteorological Module 13	Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	Water Temperature and Depth
1	Hydrological Module 15	Water Temperature, Depth and Current
1	VHF/DF MODULE 16	Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	Remotely Controllable CCTV via

Appendix B Zone 2 Puget Sound, WA

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91

Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.02	0.00	.02	.04
Passenger	Small	4.24	.73	5.00	9.97
Dry Cargo	Large	.72	.15	1.32	2.19
Dry Cargo	Medium	1.11	.21	.64	1.96
Dry Cargo	Small	21.97	2.79	4.89	29.64
Tanker	Large	.56	.14	.98	1.68
Tanker	Medium	.09	.01	.08	.18
Tanker	Small	.01	0.00	.02	.03
Dry Cargo Barge T	Small	3.38	1.19	1.94	6.52
Tanker Barge Tow	Small	1.81	.36	1.76	3.93
Tug/Tow Boat	Small	1.96	.76	2.03	4.75
		35.89	6.33	18.67	60.89

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	30	0	30	60
Passenger	Small	3,749	568	3,137	7,454
Dry Cargo	Large	1,096	263	429	1,788
Dry Cargo	Medium	1,805	406	199	2,410
Dry Cargo	Small	15,328	1,745	3,047	20,121
Tanker	Large	4,168	1,054	4,376	9,598
Tanker	Medium	152	17	42	211
Tanker	Small	11	0	4	15
Dry Cargo Barge T	Small	181	47	31	260
Tanker Barge Tow	Small	6,399	1,266	1,079	8,744
Tug/Tow Boat	Small	151	44	150	345
		33,070	5,410	12,526	51,006

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix B Zone 2 Puget Sound, WA

TABLE 10B Avoided Vessel Casualties 1996 - 2010 7/31/91
Existing VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.02	.03
Passenger	Small	3.36	.69	4.39	8.45
Dry Cargo	Large	.56	.13	1.12	1.81
Dry Cargo	Medium	.86	.19	.55	1.59
Dry Cargo	Small	17.12	2.65	4.27	24.04
Tanker	Large	.44	.13	.85	1.41
Tanker	Medium	.07	.01	.07	.15
Tanker	Small	.01	0.00	.01	.03
Dry Cargo Barge T	Small	2.62	1.14	1.69	5.45
Tanker Barge Tow	Small	1.39	.34	1.53	3.27
Tug/Tow Boat	Small	1.51	.73	1.76	3.99
		27.95	6.02	16.26	50.22

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	23	0	26	49
Passenger	Small	2,974	542	2,755	6,271
Dry Cargo	Large	841	239	364	1,444
Dry Cargo	Medium	1,391	369	170	1,930
Dry Cargo	Small	11,944	1,660	2,661	16,266
Tanker	Large	3,232	978	3,811	8,021
Tanker	Medium	117	15	37	169
Tanker	Small	8	0	4	12
Dry Cargo Barge T	Small	140	46	27	213
Tanker Barge Tow	Small	4,919	1,210	940	7,068
Tug/Tow Boat	Small	116	42	130	289
		25,707	5,100	10,925	41,732

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.27	.05	.32	.64
Dry Cargo	Large	.09	.02	.17	.27
Dry Cargo	Medium	.14	.03	.08	.25
Dry Cargo	Small	1.41	.18	.31	1.90
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		1.93	.27	.89	3.10
Candidate VTS Design - Dollars					
Passenger	Medium	2,863.22	0.00	4,635.67	7,498.89
Passenger	Small	407,316.46	69,681.46	479,960.41	956,958.33
Dry Cargo	Large	136,379.95	27,336.49	247,930.54	411,646.98
Dry Cargo	Medium	208,899.83	39,698.71	120,742.21	369,340.75
Dry Cargo	Small	2,109,587.17	267,623.25	469,566.17	2,846,776.58
Tanker	Small	49.17	0.00	51.44	100.61
Dry Cargo Barge Tow	Small	11,190.26	3,936.12	6,420.79	21,547.17
Tanker Barge Tow	Small	5,997.74	1,193.37	5,805.66	12,996.77
Tug/Tow Boat	Small	6,466.97	2,515.13	6,711.75	15,693.85
Totals		2,888,750.76	411,984.53	1,341,824.65	4,642,559.93
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.22	.04	.28	.54
Dry Cargo	Large	.07	.02	.14	.23
Dry Cargo	Medium	.11	.02	.07	.20
Dry Cargo	Small	1.10	.17	.27	1.54
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		1.50	.26	.78	2.54
Existing VTS Design - Dollars					
Passenger	Medium	2,201.05	0.00	3,941.15	6,142.21
Passenger	Small	323,092.04	66,450.60	421,529.50	811,072.15
Dry Cargo	Large	104,660.43	24,789.95	210,667.15	340,117.53
Dry Cargo	Medium	160,996.04	36,094.01	102,822.10	299,912.15
Dry Cargo	Small	1,643,857.25	254,424.86	410,120.57	2,308,402.69
Tanker	Small	38.02	0.00	44.87	82.89
Dry Cargo Barge Tow	Small	8,657.35	3,769.85	5,591.83	18,019.04
Tanker Barge Tow	Small	4,609.83	1,140.13	5,050.00	10,799.96
Tug/Tow Boat	Small	4,975.98	2,399.75	5,830.00	13,205.74
Totals		2,253,088.01	389,069.16	1,165,597.17	3,807,754.34

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	3.22	.55	3.79	7.56
Dry Cargo	Large	.01	.00	.02	.03
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	16.68	2.12	3.71	22.50
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.08	.03	.05	.16
Tanker Barge Tow	Small	.04	.01	.04	.10
Tug/Tow Boat	Small	.05	.02	.05	.12
Totals		20.09	2.73	7.67	30.49
Candidate VTS Design - Dollars					
Passenger	Medium	49.16	0.00	79.59	128.75
Passenger	Small	766,983.65	131,211.35	903,773.42	1,801,968.42
Dry Cargo	Large	2,341.61	469.36	4,256.90	7,067.87
Dry Cargo	Medium	3,586.76	681.62	2,073.11	6,341.48
Dry Cargo	Small	3,972,387.66	503,939.01	884,200.89	5,360,527.55
Tanker	Small	85.91	0.00	89.88	175.79
Dry Cargo Barge Tow	Small	19,552.89	6,877.64	11,219.14	37,649.67
Tanker Barge Tow	Small	10,479.93	2,085.20	10,144.31	22,709.44
Tug/Tow Boat	Small	11,299.82	4,394.72	11,727.54	27,422.08
Totals		4,786,767.39	649,658.90	1,827,564.78	7,263,991.07
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	2.55	.53	3.33	6.41
Dry Cargo	Large	.01	.00	.02	.02
Dry Cargo	Medium	.01	.00	.01	.02
Dry Cargo	Small	12.99	2.01	3.24	18.25
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.06	.03	.04	.13
Tanker Barge Tow	Small	.03	.01	.04	.08
Tug/Tow Boat	Small	.04	.02	.04	.10
Totals		15.70	2.59	6.72	25.01
Existing VTS Design - Dollars					
Passenger	Medium	37.79	0.00	67.67	105.46
Passenger	Small	608,387.68	125,127.58	793,747.05	1,527,262.31
Dry Cargo	Large	1,796.99	425.64	3,617.10	5,839.73
Dry Cargo	Medium	2,764.26	619.72	1,765.43	5,149.41
Dry Cargo	Small	3,095,410.49	479,086.24	772,263.84	4,346,760.57
Tanker	Small	66.43	0.00	78.41	144.83
Dry Cargo Barge Tow	Small	15,127.12	6,587.12	9,770.68	31,484.92
Tanker Barge Tow	Small	8,054.82	1,992.16	8,823.93	18,870.92
Tug/Tow Boat	Small	8,694.61	4,193.12	10,186.84	23,074.57
Totals		3,740,340.19	618,031.59	1,600,320.94	5,958,692.72

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	3.62	.48	1.57	5.67
Dry Cargo	Large	.54	.10	.13	.77
Dry Cargo	Medium	.82	.15	.06	1.04
Dry Cargo	Small	18.83	1.94	2.56	23.33
Tanker	Large	.43	.11	.13	.67
Tanker	Medium	.07	.01	.01	.09
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	2.58	.50	.27	3.36
Tanker Barge Tow	Small	1.38	.15	.24	1.78
Tug/Tow Boat	Small	.34	.09	.25	.68
Totals		28.63	3.54	5.24	37.41
Candidate VTS Design - Dollars					
Passenger	Medium	9,850.20	0.00	9,259.99	19,110.19
Passenger	Small	1,232,287.32	164,774.38	804,577.33	2,201,639.03
Dry Cargo	Large	396,396.25	76,038.26	76,350.04	548,784.55
Dry Cargo	Medium	733,536.47	133,404.49	27,799.45	894,740.42
Dry Cargo	Small	3,574,045.40	368,679.29	657,622.05	4,600,346.73
Tanker	Large	334,305.03	89,260.16	275,449.95	699,015.13
Tanker	Medium	46,985.17	5,225.44	17,928.70	70,139.32
Tanker	Small	974.45	0.00	1,329.68	2,304.13
Dry Cargo Barge Tow	Small	149,977.53	29,211.01	13,739.94	192,928.48
Tanker Barge Tow	Small	98,207.14	10,819.94	22,071.51	131,098.59
Tug/Tow Boat	Small	24,675.02	6,163.80	24,901.72	55,740.53
Totals		6,601,239.98	883,576.77	1,931,030.36	9,415,847.10
Existing VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	2.87	.46	1.38	4.71
Dry Cargo	Large	.41	.09	.11	.62
Dry Cargo	Medium	.63	.14	.05	.82
Dry Cargo	Small	14.67	1.85	2.23	18.75
Tanker	Large	.33	.11	.11	.55
Tanker	Medium	.05	.01	.01	.07
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	2.00	.48	.24	2.72
Tanker Barge Tow	Small	1.06	.15	.21	1.42
Tug/Tow Boat	Small	.27	.08	.22	.57
Totals		22.31	3.36	4.58	30.25
Existing VTS Design - Dollars					
Passenger	Medium	7,572.18	0.00	7,872.65	15,444.83
Passenger	Small	977,476.41	157,134.43	706,627.20	1,841,238.04
Dry Cargo	Large	304,201.63	68,954.89	64,874.81	438,031.32
Dry Cargo	Medium	565,325.83	121,291.17	23,673.56	710,290.57
Dry Cargo	Small	2,785,009.57	350,497.13	574,369.16	3,709,875.86
Tanker	Large	258,966.05	82,657.78	239,242.47	580,866.30
Tanker	Medium	36,306.07	4,806.40	15,458.13	56,570.61
Tanker	Small	753.41	0.00	1,159.98	1,913.39
Dry Cargo Barge Tow	Small	116,030.28	27,977.10	11,966.03	155,973.41
Tanker Barge Tow	Small	75,481.57	10,337.18	19,198.69	105,017.44
Tug/Tow Boat	Small	18,986.11	5,881.05	21,630.26	46,497.42
Totals		5,146,109.11	829,537.12	1,686,072.94	7,661,719.17

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.89	.12	.44	1.45
Dry Cargo	Large	.19	.05	.12	.36
Dry Cargo	Medium	.30	.07	.06	.43
Dry Cargo	Small	6.99	.79	.99	8.77
Tanker	Large	.15	.04	.09	.29
Tanker	Medium	.03	.00	.01	.04
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.48	.17	.11	.76
Tanker Tow	Small	.26	.05	.10	.41
Tug/Tow Boat	Small	.14	.04	.07	.25
Totals		9.41	1.35	1.99	12.75
Candidate VTS Design - Dollars					
Passenger	Medium	43.33	0.00	28.82	72.15
Passenger	Small	3,116.36	416.69	1,817.03	5,350.09
Dry Cargo	Large	2,040.86	579.57	350.85	2,971.28
Dry Cargo	Medium	3,126.08	841.67	170.86	4,138.61
Dry Cargo	Small	16,220.00	1,673.17	2,952.00	20,845.17
Tanker	Large	10,803.69	2,735.22	15,390.64	28,929.55
Tanker	Medium	366.83	40.16	102.11	509.10
Tanker	Small	12.61	0.00	8.15	20.76
Tanker Tow	Small	23,097.87	4,591.83	9,091.44	36,781.14
Tug/Tow Boat	Small	297.03	74.19	291.78	662.99
Totals		59,124.65	10,952.49	30,203.68	100,280.83
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.70	.12	.38	1.20
Dry Cargo	Large	.15	.05	.10	.30
Dry Cargo	Medium	.23	.07	.05	.34
Dry Cargo	Small	5.44	.75	.86	7.06
Tanker	Large	.12	.04	.08	.24
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.37	.16	.10	.63
Tanker Tow	Small	.20	.05	09	.33
Tug/Tow Boat	Small	.10	.04	.06	.21
Totals		7.34	1.27	1.74	10.35
Existing VTS Design - Dollars					
Passenger	Medium	322.02	0.00	236.86	558.88
Passenger	Small	2,471.97	397.37	1,595.82	4,465.16
Dry Cargo	Large	1,539.37	516.56	292.98	2,348.91
Dry Cargo	Medium	2,369.80	752.68	143.08	3,265.56
Dry Cargo	Small	12,529.02	1,575.90	2,551.24	16,656.16
Tanker	Large	9,002.14	2,721.06	14,533.63	26,256.82
Tanker	Medium	287.19	37.36	93.42	417.97
Tanker	Small	10.40	0.00	7.37	17.77
Tanker Tow	Small	19,507.10	4,817.93	8,683.04	33,008.07
Tug/Tow Boat	Small	227.42	70.43	252.11	549.96
Totals		48,266.43	10,889.29	28,389.53	87,545.25

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.08	.03	.11
Dry Cargo	Large	0.00	.02	.01	.02
Dry Cargo	Medium	0.00	.02	.00	.03
Dry Cargo	Small	0.00	.32	.03	.35
Tanker	Large	0.00	.02	.01	.02
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.14	.01	.15
Tanker Barge Tow	Small	0.00	.04	.01	.05
Tug/Tow Boat	Small	0.00	.09	.01	.10
Totals		0.00	.72	.11	.83
Candidate VTS Design - Dollars					
Passenger	Small	0.00	468.47	161.54	630.01
Dry Cargo	Large	0.00	93.81	42.59	136.41
Dry Cargo	Medium	0.00	136.24	20.74	156.98
Dry Cargo	Small	0.00	1,799.24	158.04	1,957.28
Tanker	Large	0.00	91.64	31.53	123.16
Tanker	Medium	0.00	6.37	2.46	8.83
Tanker	Small	0.00	0.00	.50	.50
Dry Cargo Barge Tow	Small	0.00	768.67	62.77	831.44
Tanker Barge Tow	Small	0.00	233.05	56.76	289.81
Tug/Tow Boat	Small	0.00	491.17	65.62	556.78
Totals		0.00	4,088.65	602.55	4,691.20
Existing VTS Design - Counts					
Passenger	Small	0.00	.08	.03	.10
Dry Cargo	Large	0.00	.02	.01	.02
Dry Cargo	Medium	0.00	.02	.00	.03
Dry Cargo	Small	0.00	.30	.02	.33
Tanker	Large	0.00	.02	.00	.02
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.13	.01	.14
Tanker Barge Tow	Small	0.00	.04	.01	.05
Tug/Tow Boat	Small	0.00	.08	.01	.09
Totals		0.00	.69	.09	.78
Existing VTS Design - Dollars					
Passenger	Small	0.00	446.75	141.87	588.62
Dry Cargo	Large	0.00	85.07	36.19	121.26
Dry Cargo	Medium	0.00	123.87	17.66	141.53
Dry Cargo	Small	0.00	1,710.51	138.03	1,848.54
Tanker	Large	0.00	84.86	27.38	112.24
Tanker	Medium	0.00	5.86	2.12	7.98
Tanker	Small	0.00	0.00	.44	.44
Dry Cargo Barge Tow	Small	0.00	736.20	54.67	790.86
Tanker Barge Tow	Small	0.00	222.65	49.37	272.02
Tug/Tow Boat	Small	0.00	468.64	57.00	525.63
Totals		0.00	3,384.40	524.73	4,409.13

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.01	0.00	.01
Dry Cargo Barge Tow	Small	.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.00	0.00	.00
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.02	0.00	.02
Candidate VTS Design - Dollars					
Passenger	Small	927.95	11,882.89	0.00	12,810.84
Dry Cargo	Medium	0.00	730.36	0.00	730.36
Dry Cargo	Small	1,657.23	16,154.15	0.00	17,811.38
Dry Cargo Barge Tow	Small	254.48	6,604.49	0.00	6,858.96
Tanker Barge Tow	Small	13.25	198.46	0.00	211.71
Tug/Tow Boat	Small	89.47	2,602.78	0.00	2,692.25
Totals		2,942.37	38,173.13	0.00	41,115.50
Existing VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.01	0.00	.01
Dry Cargo Barge Tow	Small	.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.00	0.00	.00
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.02	0.00	.02
Existing VTS Design - Dollars					
Passenger	Small	927.95	11,882.89	0.00	12,810.84
Dry Cargo	Medium	0.00	730.36	0.00	730.36
Dry Cargo	Small	1,657.23	16,154.15	0.00	17,811.38
Dry Cargo Barge Tow	Small	254.48	6,604.49	0.00	6,858.96
Tanker Barge Tow	Small	13.25	198.46	0.00	211.71
Tug/Tow Boat	Small	89.47	2,602.78	0.00	2,692.25
Totals		2,942.37	38,173.13	0.00	41,115.50

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix B Zone 2 Puget Sound, WA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
ALCOHOLS	0.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.02
DISTILLATE FUEL OIL	.00	.01	.04	6.45	6.50
GASOLINE, INCL NATURAL	.00	.01	.04	.00	.06
RESIDUAL FUEL OIL	.01	.07	.37	.48	.93
CRUDE PETROLEUM	.02	.03	.00	.00	.05
	.03	.13	.46	6.94	7.56
Existing Vts Design - Counts					
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
ALCOHOLS	0.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.01
DISTILLATE FUEL OIL	.00	.01	.03	5.24	5.29
GASOLINE, INCL NATURAL	.00	.01	.03	.00	.05
RESIDUAL FUEL OIL	.01	.06	.30	.38	.75
CRUDE PETROLEUM	.01	.03	.00	.00	.04
	.03	.11	.37	5.63	6.14

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix B
TABLE 18A

Zone 2 Puget Sound, WA
Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,175	0	0
1996	0	1,141	2,374
1997	0	1,038	2,191
1998	0	943	2,022
1999	0	857	1,866
2000	0	780	1,721
2001	0	709	1,593
2002	0	644	1,474
2003	0	586	1,364
2004	0	532	1,261
2005	0	484	1,166
2006	0	440	1,083
2007	0	400	1,005
2008	0	364	932
2009	0	331	864
2010	0	301	801
	16,175	9,549	21,717

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,175	0	0
1996	0	1,450	3,016
1997	0	1,450	3,062
1998	0	1,450	3,109
1999	0	1,450	3,155
2000	0	1,450	3,202
2001	0	1,450	3,260
2002	0	1,450	3,318
2003	0	1,450	3,376
2004	0	1,450	3,435
2005	0	1,450	3,494
2006	0	1,450	3,567
2007	0	1,450	3,641
2008	0	1,450	3,716
2009	0	1,450	3,790
2010	0	1,450	3,865
	16,175	21,750	51,006

Appendix B TABLE 18B — Zone 2 Puget Sound, WA

Annual Benefit & Cost Streams
Existing VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	3,581	1,944
1997	0	3,256	1,794
1998	0	2,960	1,656
1999	0	2,691	1,527
2000	0	2,446	1,409
2001	0	2,224	1,304
2002	0	2,022	1,207
2003	0	1,838	1,116
2004	0	1,671	1,032
2005	0	1,519	954
2006	0	1,381	885
2007	0	1,255	822
2008	0	1,141	762
2009	0	1,037	706
2010	0	943	655
	0	29,963	17,772

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	4,550	2,469
1997	0	4,550	2,507
1998	0	4,550	2,545
1999	0	4,550	2,583
2000	0	4,550	2,621
2001	0	4,550	2,668
2002	0	4,550	2,716
2003	0	4,550	2,763
2004	0	4,550	2,810
2005	0	4,550	2,858
2006	0	4,550	2,918
2007	0	4,550	2,978
2008	0	4,550	3,038
2009	0	4,550	3,098
2010	0	4,550	3,159
	0	68,250	41,732

APPENDIX B

ZONE 2 - PUGET SOUND, WA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	Species Category	(Port 2) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0200	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0201	101	81	Chinook Salmon	.0023	0.0000	.0023	0.0000
0201	101	82	Coho Salmon	.0021	0.0000	.0021	0.0000
0201	102	86	Pacific Herring	0.0000	0.0000	3.7200	0.0000
0201	102	97	Walleye Pollock	.0229	.0229	.0229	.0229
0201	105	88	Pacific Halibut	4.8100	4.8100	4.8100	4.8100
0201	105	100	Arrowtooth Flounder	.0008	.0008	.0008	.0008
0201	105	104	Starry Flounder	.0827	.0827	.0827	0.0000
0201	105	106	Dover Sole	.0043	.0043	.0043	0.0000
0201	105	107	English Sole	.2357	.2357	.2357	.2357
0201	105	108	Rock Sole	.2275	.2275	.2275	0.0000
0201	105	117	Ratfish	.0002	.0002	.0002	.0002
0201	105	137	Sand Sole	.0208	.0208	.0208	0.0000
0201	106	89	Sea Perch (Pacific)	.0014	.0014	.0014	.0014
0201	106	90	Rockfish	.1517	.1517	.1517	.1517
0201	106	92	Sablefish	.0084	.0084	.0084	.0084
0201	106	93	Pacific Cod	.6095	.6095	.6095	.6095
0201	106	94	Ling Cod	.0981	.0981	.0981	.0981
0201	106	95	Pacific Hake	.0045	.0045	.0045	.0045
0201	106	103	Surf Smelt	.0006	.0006	.0006	.0006
0201	106	109	Sculpin	.0019	.0019	.0019	.0019
0201	106	116	Skate	.0234	.0234	.0234	.0234
0201	106	118	Greenling	.0052	.0052	.0052	.0052
0201	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0201	107	228	Geoduc	5.2332	5.2332	5.2332	5.2332
0201	108	221	Dungeness Crab	.0349	.0349	.0349	.0349
0201	108	222	Pandalid Shrimp	.0001	.0001	.0001	.0001
0202	101	81	Chinook Salmon	.0423	0.0000	.0423	0.0000
0202	101	82	Coho Salmon	.0045	0.0000	.0045	0.0000
0202	102	86	Pacific Herring	0.0000	0.0000	3.7200	0.0000
0202	102	97	Walleye Pollock	.0229	.0229	.0229	.0229
0202	104	14	Shark	.0014	.0014	.0014	.0014
0202	104	15	Dogfish	9.8584	9.8584	9.8584	9.8584
0202	105	87	Other Flatfish	.0108	.0108	.0108	0.0000
0202	105	87	Other Flatfish	.0108	.0108	.0108	0.0000
0202	105	87	Other Flatfish	.0108	.0108	.0108	0.0000
0202	105	87	Other Flatfish	.0108	.0108	.0108	0.0000
0202	105	88	Pacific Halibut	4.8100	4.8100	4.8100	4.8100
0202	105	100	Arrowtooth Flounder	.0008	.0008	.0008	.0008
0202	105	104	Starry Flounder	.0827	.0827	.0827	0.0000
0202	105	106	Dover Sole	.0043	.0043	.0043	0.0000
0202	105	107	English Sole	.2357	.2357	.2357	.2357
0202	105	108	Rock Sole	.2275	.2275	.2275	0.0000
0202	105	117	Ratfish	.0002	.0002	.0002	.0002
0202	105	137	Sand Sole	.0208	.0208	.0208	0.0000
0202	106	89	Sea Perch (Pacific)	.0014	.0014	.0014	.0014
0202	106	90	Rockfish	.1517	.1517	.1517	.1517
0202	106	92	Sablefish	.0084	.0084	.0084	.0084
0202	106	93	Pacific Cod	.6095	.6095	.6095	.6095
0202	106	94	Ling Cod	.0981	.0981	.0981	.0981
0202	106	95	Pacific Hake	.0045	.0045	.0045	.0045
0202	106	103	Surf Smelt	.0006	.0006	.0006	.0006
0202	106	109	Sculpin	.0019	.0019	.0019	.0019
0202	106	116	Skate	.0234	.0234	.0234	.0234
0202	106	118	Greenling	.0052	.0052	.0052	.0052

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound		(Port 2)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0202	107	208	Blue Mussel	.0151	.0151	.0151	.0151
0202	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0202	107	226	Butter Clam	.1350	.1350	.1350	.1350
0202	107	227	Horse Clam	.0340	.0340	.0340	.0340
0202	107	228	Geoduc	5.2332	5.2332	5.2332	5.2332
0202	108	221	Dungeness Crab	.0349	.0349	.0349	.0349
0202	108	222	Pandalid Shrimp	.0001	.0001	.0001	.0001
0203	101	79	Chum	0.0000	0.0000	.0002	0.0000
0203	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0203	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0203	102	86	Pacific Herring	0.0000	0.0000	3.7204	3.7204
0203	102	97	Walleye Pollock	2.2559	2.2559	2.2559	2.2559
0203	104	15	Dogfish	10.7914	10.7914	10.7914	10.7914
0203	105	87	Other Flatfish	2.3000	2.3000	2.3000	0.0000
0203	105	100	Arrowtooth Flounder	.0385	.0385	.0385	.0385
0203	105	104	Starry Flounder	.5683	.5683	.5683	0.0000
0203	105	105	Butter Sole	.1660	.1660	.1660	0.0000
0203	105	106	Dover Sole	.1305	.1305	.1305	0.0000
0203	105	107	English Sole	1.7132	1.7132	1.7132	1.7132
0203	105	108	Rock Sole	4.5840	4.5840	4.5840	0.0000
0203	105	113	Sand Dab	.0119	.0119	.0119	.0119
0203	105	117	Ratfish	.0003	.0003	.0003	.0003
0203	105	137	Sand Sole	.1159	.1159	.1159	0.0000
0203	105	138	C-O Sole	1.1800	1.1800	1.1800	0.0000
0203	105	138	C-O Sole	1.1800	1.1800	1.1800	0.0000
0203	105	138	C-O Sole	1.1800	1.1800	1.1800	0.0000
0203	105	138	C-O Sole	1.1800	1.1800	1.1800	0.0000
0203	105	138	C-O Sole	1.1800	1.1800	1.1800	0.0000
0203	105	139	Speckled Sand Dab	.3532	.3532	.3532	0.0000
0203	106	90	Rockfish	.1548	.1548	.1548	.1548
0203	106	92	Sablefish	.0118	.0118	.0118	.0118
0203	106	93	Pacific Cod	.7402	.7402	.7402	.7402
0203	106	94	Ling Cod	.0507	.0507	.0507	.0507
0203	106	95	Pacific Hake	.0001	.0001	.0001	.0001
0203	106	103	Surf Smelt	.0257	.0257	.0257	.0257
0203	106	109	Sculpin	.0016	.0016	.0016	.0016
0203	106	115	Pacific Tomcod	.0015	.0015	.0015	.0015
0203	106	116	Skate	.0063	.0063	.0063	.0063
0203	106	118	Greenling	.0033	.0033	.0033	.0033
0203	107	208	Blue Mussel	.0151	.0151	.0151	.0151
0203	107	211	Little Neck Clam	.0330	.0330	.0330	.0330
0203	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0203	107	226	Butter Clam	.1350	.1350	.1350	.1350
0203	107	227	Horse Clam	.0340	.0340	.0340	.0340
0203	107	228	Geoduc	15.6996	15.6996	15.6996	15.6996
0203	107	230	Pacific Oyster	.0370	.0370	.0370	.0370
0203	108	221	Dungeness Crab	.1368	.1368	.1368	.1368
0203	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472
0204	101	81	Chinook Salmon	.0099	0.0000	.0099	0.0000
0204	101	82	Coho Salmon	.0070	0.0000	.0070	0.0000
0204	102	86	Pacific Herring	0.0000	0.0000	3.7200	0.0000
0204	102	97	Walleye Pollock	.0229	.0229	.0229	.0229
0204	105	88	Pacific Halibut	4.8100	4.8100	4.8100	4.8100
0204	105	100	Arrowtooth Flounder	.0008	.0008	.0008	.0008
0204	105	104	Starry Flounder	.0827	.0827	.0827	0.0000

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	Species Category	(Port 2) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0204	105	106	Dover Sole	.0043	.0043	.0043	0.0000
0204	105	107	English Sole	.2357	.2357	.2357	.2357
0204	105	108	Rock Sole	.2275	.2275	.2275	0.0000
0204	105	117	Ratfish	.0002	.0002	.0002	.0002
0204	105	137	Sand Sole	.0208	.0208	.0208	0.0000
0204	106	89	Sea Perch (Pacific)	.0014	.0014	.0014	.0014
0204	106	90	Rockfish	.1517	.1517	.1517	.1517
0204	106	92	Sablefish	.0084	.0084	.0084	.0084
0204	106	93	Pacific Cod	.6095	.6095	.6095	.6095
0204	106	94	Ling Cod	.0981	.0981	.0981	.0981
0204	106	95	Pacific Hake	.0045	.0045	.0045	.0045
0204	106	103	Surf Smelt	.0006	.0006	.0006	.0006
0204	106	109	Sculpin	.0019	.0019	.0019	.0019
0204	106	116	Skate	.0234	.0234	.0234	.0234
0204	106	118	Greenling	.0052	.0052	.0052	.0052
0204	107	208	Blue Mussel	.0151	.0151	.0151	.0151
0204	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0204	107	226	Butter Clam	.1350	.1350	.1350	.1350
0204	107	227	Horse Clam	.0340	.0340	.0340	.0340
0204	107	228	Geoduc	5.2332	5.2332	5.2332	5.2332
0204	108	221	Dungeness Crab	.5037	.5037	.5037	.5037
0204	108	222	Pandalid Shrimp	.3663	.3663	.3663	.3663
0205	101	81	Chinook Salmon	.0099	0.0000	.0099	0.0000
0205	101	82	Coho Salmon	.0070	0.0000	.0070	0.0000
0205	102	86	Pacific Herring	0.0000	0.0000	3.7200	0.0000
0205	102	97	Walleye Pollock	.0229	.0229	.0229	.0229
0205	105	88	Pacific Halibut	4.8100	4.8100	4.8100	4.8100
0205	105	100	Arrowtooth Flounder	.0008	.0008	.0008	.0008
0205	105	104	Starry Flounder	.0827	.0827	.0827	0.0000
0205	105	106	Dover Sole	.0043	.0043	.0043	0.0000
0205	105	107	English Sole	.2357	.2357	.2357	.2357
0205	105	108	Rock Sole	.2275	.2275	.2275	0.0000
0205	105	117	Ratfish	.0002	.0002	.0002	.0002
0205	105	137	Sand Sole	.0208	.0208	.0208	0.0000
0205	106	89	Sea Perch (Pacific)	.0014	.0014	.0014	.0014
0205	106	90	Rockfish	.1517	.1517	.1517	.1517
0205	106	92	Sablefish	.0084	.0084	.0084	.0084
0205	106	93	Pacific Cod	.6095	.6095	.6095	.6095
0205	106	94	Ling Cod	.0981	.0981	.0981	.0981
0205	106	95	Pacific Hake	.0045	.0045	.0045	.0045
0205	106	103	Surf Smelt	.0006	.0006	.0006	.0006
0205	106	109	Sculpin	.0019	.0019	.0019	.0019
0205	106	116	Skate	.0234	.0234	.0234	.0234
0205	106	118	Greenling	.0052	.0052	.0052	.0052
0205	107	208	Blue Mussel	.0151	.0151	.0151	.0151
0205	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0205	107	226	Butter Clam	.1350	.1350	.1350	.1350
0205	107	227	Horse Clam	.0340	.0340	.0340	.0340
0205	107	228	Geoduc	5.2332	5.2332	5.2332	5.2332
0205	108	221	Dungeness Crab	1.0585	1.0585	1.0585	1.0585
0205	108	222	Pandalid Shrimp	.3663	.3663	.3663	.3663
0206	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0206	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0206	102	86	Pacific Herring	0.0000	0.0000	3.7204	3.7204
0206	102	97	Walleye Pollock	2.2559	2.2559	2.2559	2.2559

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	Species Category	(Port 2) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0206	105	87	Other Flatfish	2.3000	2.3000	2.3000	0.0000
0206	105	100	Arrowtooth Flounder	.0385	.0385	.0385	.0385
0206	105	104	Starry Flounder	.5683	.5683	.5683	0.0000
0206	105	105	Butter Sole	.1660	.1660	.1660	0.0000
0206	105	106	Dover Sole	.1305	.1305	.1305	0.0000
0206	105	107	English Sole	1.7132	1.7132	1.7132	1.7132
0206	105	108	Rock Sole	4.5840	4.5840	4.5840	0.0000
0206	105	113	Sand Dab	.0119	.0119	.0119	.0119
0206	105	117	Ratfish	.0003	.0003	.0003	.0003
0206	105	137	Sand Sole	.1159	.1159	.1159	0.0000
0206	105	139	Speckled Sand Dab	.3532	.3532	.3532	0.0000
0206	106	90	Rockfish	.1548	.1548	.1548	.1548
0206	106	92	Sablefish	.0118	.0118	.0118	.0118
0206	106	93	Pacific Cod	.7402	.7402	.7402	.7402
0206	106	94	Ling Cod	.0507	.0507	.0507	.0507
0206	106	95	Pacific Hake	.0001	.0001	.0001	.0001
0206	106	103	Surf Smelt	.0257	.0257	.0257	.0257
0206	106	109	Sculpin	.0016	.0016	.0016	.0016
0206	106	115	Pacific Tomcod	.0015	.0015	.0015	.0015
0206	106	116	Skate	.0063	.0063	.0063	.0063
0206	106	118	Greenling	.0033	.0033	.0033	.0033
0206	107	211	Little Neck Clam	.0330	.0330	.0330	.0330
0206	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0206	107	228	Geoduc	15.6996	15.6996	15.6996	15.6996
0206	107	230	Pacific Oyster	.0370	.0370	.0370	.0370
0206	108	221	Dungeness Crab	.1368	.1368	.1368	.1368
0206	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472
0207	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0207	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0207	102	86	Pacific Herring	0.0000	0.0000	3.7204	3.7204
0207	102	97	Walleye Pollock	2.2559	2.2559	2.2559	2.2559
0207	105	87	Other Flatfish	2.3000	2.3000	2.3000	0.0000
0207	105	100	Arrowtooth Flounder	.0385	.0385	.0385	.0385
0207	105	104	Starry Flounder	.5683	.5683	.5683	0.0000
0207	105	105	Butter Sole	.1660	.1660	.1660	0.0000
0207	105	106	Dover Sole	.1305	.1305	.1305	0.0000
0207	105	107	English Sole	1.7132	1.7132	1.7132	1.7132
0207	105	108	Rock Sole	4.5840	4.5840	4.5840	0.0000
0207	105	113	Sand Dab	.0119	.0119	.0119	.0119
0207	105	117	Ratfish	.0003	.0003	.0003	.0003
0207	105	137	Sand Sole	.1159	.1159	.1159	0.0000
0207	105	139	Speckled Sand Dab	.3532	.3532	.3532	0.0000
0207	106	90	Rockfish	.1548	.1548	.1548	.1548
0207	106	92	Sablefish	.0118	.0118	.0118	.0118
0207	106	93	Pacific Cod	.7402	.7402	.7402	.7402
0207	106	94	Ling Cod	.0507	.0507	.0507	.0507
0207	106	95	Pacific Hake	.0001	.0001	.0001	.0001
0207	106	103	Surf Smelt	.0257	.0257	.0257	.0257
0207	106	109	Sculpin	.0016	.0016	.0016	.0016
0207	106	115	Pacific Tomcod	.0015	.0015	.0015	.0015
0207	106	116	Skate	.0063	.0063	.0063	.0063
0207	106	118	Greenling	.0033	.0033	.0033	.0033
0207	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0207	107	228	Geoduc	15.6996	15.6996	15.6996	15.6996
0207	108	221	Dungeness Crab	.1368	.1368	.1368	.1368

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	(Port 2) Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0207	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472
0208	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0208	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0208	102	86	Pacific Herring	0.0000	0.0000	15.9320	15.9320
0208	102	97	Walleye Pollock	2.2559	2.2559	2.2559	2.2559
0208	105	87	Other Flatfish	2.3000	2.3000	2.3000	0.0000
0208	105	100	Arrowtooth Flounder	.0385	.0385	.0385	.0385
0208	105	104	Starry Flounder	.5683	.5683	.5683	0.0000
0208	105	105	Butter Sole	.1660	.1660	.1660	0.0000
0208	105	106	Dover Sole	.1305	.1305	.1305	0.0000
0208	105	107	English Sole	1.7132	1.7132	1.7132	1.7132
0208	105	108	Rock Sole	4.5840	4.5840	4.5840	0.0000
0208	105	113	Sand Dab	.0119	.0119	.0119	.0119
0208	105	117	Ratfish	.0003	.0003	.0003	.0003
0208	105	137	Sand Sole	.1159	.1159	.1159	0.0000
0208	105	139	Speckled Sand Dab	.3532	.3532	.3532	0.0000
0208	106	90	Rockfish	.1548	.1548	.1548	.1548
0208	106	92	Sablefish	.0118	.0118	.0118	.0118
0208	106	93	Pacific Cod	.7402	.7402	.7402	.7402
0208	106	94	Ling Cod	.0507	.0507	.0507	.0507
0208	106	95	Pacific Hake	.0001	.0001	.0001	.0001
0208	106	103	Surf Smelt	.0257	.0257	.0257	.0257
0208	106	109	Sculpin	.0016	.0016	.0016	.0016
0208	106	115	Pacific Tomcod	.0015	.0015	.0015	.0015
0208	106	116	Skate	.0063	.0063	.0063	.0063
0208	106	118	Greenling	.0033	.0033	.0033	.0033
0208	107	211	Little Neck Clam	.0330	.0330	.0330	.0330
0208	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0208	107	228	Geoduc	15.6996	15.6996	15.6996	15.6996
0208	107	230	Pacific Oyster	.0370	.0370	.0370	.0370
0208	108	221	Dungeness Crab	.0964	.0964	.0964	.0964
0208	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472
0209	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0209	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0209	102	86	Pacific Herring	0.0000	0.0000	12.3800	8.9410
0209	104	15	Dogfish	7.2532	7.2532	7.2532	7.2532
0209	105	87	Other Flatfish	.1544	.1544	.1544	0.0000
0209	105	104	Starry Flounder	.0693	.0693	.0693	0.0000
0209	105	107	English Sole	.8512	.8512	.8512	.8512
0209	105	108	Rock Sole	.0095	.0095	.0095	0.0000
0209	105	113	Sand Dab	.0004	.0004	.0004	.0004
0209	105	137	Sand Sole	.0539	.0539	.0539	0.0000
0209	106	90	Rockfish	.1350	.1350	.1350	.1350
0209	106	92	Sablefish	.0002	.0002	.0002	.0002
0209	106	93	Pacific Cod	.3461	.3461	.3461	.3461
0209	106	94	Ling Cod	.0006	.0006	.0006	.0006
0209	106	95	Pacific Hake	.0093	.0093	.0093	.0093
0209	106	103	Surf Smelt	.0062	.0062	.0062	.0062
0209	106	118	Greenling	.0002	.0002	.0002	.0002
0209	107	211	Little Neck Clam	.0330	.0330	.0330	.0330
0209	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0209	107	228	Geoduc	17.4440	17.4440	17.4440	17.4440
0209	107	230	Pacific Oyster	.0370	.0370	.0370	.0370
0209	108	221	Dungeness Crab	.5037	.5037	.5037	.5037

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Puget Sound (Port 2)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0209	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472
0210	101	81	Chinook Salmon	.0446	0.0000	.0446	0.0000
0210	101	82	Coho Salmon	.0282	0.0000	.0282	0.0000
0210	102	86	Pacific Herring	0.0000	0.0000	3.7204	3.7204
0210	102	97	Walleye Pollock	2.2559	2.2559	2.2559	2.2559
0210	105	87	Other Flatfish	2.3000	2.3000	2.3000	0.0000
0210	105	100	Arrowtooth Flounder	.0385	.0385	.0385	.0385
0210	105	104	Starry Flounder	.5683	.5683	.5683	0.0000
0210	105	105	Butter Sole	.1660	.1660	.1660	0.0000
0210	105	106	Dover Sole	.1305	.1305	.1305	0.0000
0210	105	107	English Sole	1.7132	1.7132	1.7132	1.7132
0210	105	108	Rock Sole	4.5840	4.5840	4.5840	0.0000
0210	105	113	Sand Dab	.0119	.0119	.0119	.0119
0210	105	117	Ratfish	.0003	.0003	.0003	.0003
0210	105	137	Sand Sole	.1159	.1159	.1159	0.0000
0210	105	139	Speckled Sand Dab	.3532	.3532	.3532	0.0000
0210	106	90	Rockfish	.1548	.1548	.1548	.1548
0210	106	92	Sablefish	.0118	.0118	.0118	.0118
0210	106	93	Pacific Cod	.7402	.7402	.7402	.7402
0210	106	94	Ling Cod	.0507	.0507	.0507	.0507
0210	106	95	Pacific Hake	.0001	.0001	.0001	.0001
0210	106	103	Surf Smelt	.0257	.0257	.0257	.0257
0210	106	109	Sculpin	.0016	.0016	.0016	.0016
0210	106	115	Pacific Tomcod	.0015	.0015	.0015	.0015
0210	106	116	Skate	.0063	.0063	.0063	.0063
0210	106	118	Greenling	.0033	.0033	.0033	.0033
0210	107	211	Soft Shell Clam	.0220	.0220	.0220	.0220
0210	107	228	Geoduc	15.6996	15.6996	15.6996	15.6996
0210	108	221	Dungeness Crab	.1368	.1368	.1368	.1368
0210	108	222	Pandalid Shrimp	.0472	.0472	.0472	.0472

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	Species Category	(Port 2) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0201	202	1199	Larvae	.3000	1.3000	1.3000	.3500
0201	205	1199	Larvae	5.5000	3.3000	1.8000	.0200
0201	206	1199	Larvae	.3500	.6000	1.3000	.0260
0201	207	1199	Larvae	.0002	.0019	.0003	0.0000
0201	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0202	202	1199	Larvae	.3000	1.3000	1.3000	.3500
0202	205	1199	Larvae	5.5000	3.3000	1.8000	.0200
0202	206	1199	Larvae	.3500	.6000	1.3000	.0260
0202	207	1199	Larvae	.0002	.0019	.0003	0.0000
0202	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0203	202	1086	Pacific Herring	4.4080	0.0000	0.0000	0.0000
0203	205	1104	Starry Flounder	2.4880	0.0000	0.0000	0.0000
0203	205	1105	Butter Sole	1.0608	0.0000	0.0000	0.0000
0203	205	1107	English Sole	8.1250	0.0000	0.0000	0.0000
0203	205	1137	Sand Sole	1.2520	0.0000	0.0000	0.0000
0203	205	1140	Slender Sole	9.9350	0.0000	0.0000	0.0000
0203	206	1090	Rockfish	13.9000	13.9000	13.9000	13.9000
0203	206	1093	Pacific Cod	0.0000	0.0000	0.0000	13.1260
0203	206	1094	Ling Cod	.0210	0.0000	0.0000	0.0000
0203	206	1095	Pacific Hake	27.8190	0.0000	0.0000	0.0000
0203	206	1103	Surf Smelt	.0260	0.0000	0.0000	0.0000
0203	206	1109	Sculpin	.5170	.5170	.5170	.5170
0203	206	1110	Sand Lance	6.9300	0.0000	0.0000	0.0000
0203	206	1111	Poachers	.0950	0.0000	0.0000	0.0000
0203	206	1112	Lump, Snail Fishes	.6230	0.0000	0.0000	0.0000
0203	206	1199	Other Larvae	6.8520	0.0000	0.0000	0.0000
0204	202	1086	Pacific Herring	4.4080	0.0000	0.0000	0.0000
0205	202	1199	Larvae	.3000	1.3000	1.3000	.3500
0205	205	1199	Larvae	5.5000	3.3000	1.8000	.0200
0205	206	1199	Larvae	.3500	.6000	1.3000	.0260
0205	207	1199	Larvae	.0002	.0019	.0003	0.0000
0205	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0206	202	1110	Sand Lance	1.8550	0.0000	0.0000	0.0000
0206	205	1104	Starry Flounder	.3710	0.0000	0.0000	0.0000
0206	205	1104	Starry Flounder	2.4880	0.0000	0.0000	0.0000
0206	205	1105	Butter Sole	1.0608	0.0000	0.0000	0.0000
0206	205	1107	English Sole	8.1250	0.0000	0.0000	0.0000
0206	205	1107	English Sole	8.9040	0.0000	0.0000	0.0000
0206	205	1137	Sand Sole	1.2520	0.0000	0.0000	0.0000
0206	205	1140	Slender Sole	.7420	0.0000	0.0000	0.0000
0206	205	1140	Slender Sole	9.9350	0.0000	0.0000	0.0000
0206	206	1090	Rockfish	7.0490	7.0490	7.0490	7.0490
0206	206	1093	Pacific Cod	0.0000	0.0000	0.0000	11.5010
0206	206	1094	Ling Cod	.0210	0.0000	0.0000	0.0000
0206	206	1095	Pacific Hake	12.6140	0.0000	0.0000	0.0000
0206	206	1103	Surf Smelt	.0260	0.0000	0.0000	0.0000
0206	206	1109	Sculpin	.5170	.5170	.5170	.5170
0206	206	1111	Poachers	.0950	0.0000	0.0000	0.0000
0206	206	1112	Lump, Snail Fishes	.6230	0.0000	0.0000	0.0000
0206	206	1199	Other Larvae	2.5970	0.0000	0.0000	0.0000
0206	206	1199	Other Larvae	6.8520	0.0000	0.0000	0.0000
0207	202	1086	Pacific Herring	4.4080	0.0000	0.0000	0.0000
0207	205	1104	Starry Flounder	2.4880	0.0000	0.0000	0.0000
0207	205	1105	Butter Sole	1.0608	0.0000	0.0000	0.0000
0207	205	1107	English Sole	8.1250	0.0000	0.0000	0.0000

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound	(Port 2)			Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0207	205	1137	Sand Sole	1.2520	0.0000	0.0000	0.0000
0207	205	1140	Slender Sole	9.9350	0.0000	0.0000	0.0000
0207	206	1090	Rockfish	13.9000	13.9000	13.9000	13.9000
0207	206	1093	Pacific Cod	0.0000	0.0000	0.0000	13.1260
0207	206	1094	Ling Cod	.0210	0.0000	0.0000	0.0000
0207	206	1095	Pacific Hake	27.8190	0.0000	0.0000	0.0000
0207	206	1103	Surf Smelt	.0260	0.0000	0.0000	0.0000
0207	206	1109	Sculpin	.5170	.5170	.5170	.5170
0207	206	1110	Sand Lance	6.9300	0.0000	0.0000	0.0000
0207	206	1111	Poachers	.0950	0.0000	0.0000	0.0000
0207	206	1112	Lump, Snail Fishes	.6230	0.0000	0.0000	0.0000
0207	206	1199	Other Larvae	6.8520	0.0000	0.0000	0.0000
0208	202	1086	Pacific Herring	4.4080	0.0000	0.0000	0.0000
0208	205	1104	Starry Flounder	2.4880	0.0000	0.0000	0.0000
0208	205	1105	Butter Sole	1.0608	0.0000	0.0000	0.0000
0208	205	1107	English Sole	8.1250	0.0000	0.0000	0.0000
0208	205	1137	Sand Sole	1.2520	0.0000	0.0000	0.0000
0208	205	1140	Slender Sole	9.9350	0.0000	0.0000	0.0000
0208	206	1090	Rockfish	13.9000	13.9000	13.9000	13.9000
0208	206	1093	Pacific Cod	0.0000	0.0000	0.0000	13.1260
0208	206	1094	Ling Cod	.0210	0.0000	0.0000	0.0000
0208	206	1095	Pacific Hake	27.8190	0.0000	0.0000	0.0000
0208	206	1103	Surf Smelt	.0260	0.0000	0.0000	0.0000
0208	206	1109	Sculpin	.5170	.5170	.5170	.5170
0208	206	1110	Sand Lance	6.9300	0.0000	0.0000	0.0000
0208	206	1111	Poachers	.0950	0.0000	0.0000	0.0000
0208	206	1112	Lump, Snail Fishes	.6230	0.0000	0.0000	0.0000
0208	206	1199	Other Larvae	6.8520	0.0000	0.0000	0.0000
0209	202	1086	Pacific Herring	.2100	0.0000	0.0000	0.0000
0209	202	1110	Sand Lance	.1980	0.0000	0.0000	0.0000
0209	205	1104	Starry Flounder	1.2720	0.0000	0.0000	0.0000
0209	205	1107	English Sole	19.6890	0.0000	0.0000	0.0000
0209	205	1113	Sand Dab	.0670	0.0000	0.0000	0.0000
0209	205	1137	Sand Sole	7.5960	0.0000	0.0000	0.0000
0209	205	1140	Slender Sole	3.8470	0.0000	0.0000	0.0000
0209	205	1141	Flathead Sole	.3650	0.0000	0.0000	0.0000
0209	206	1090	Rockfish	9.6510	9.6510	9.6510	9.6510
0209	206	1093	Pacific Cod	0.0000	0.0000	0.0000	7.7160
0209	206	1095	Pacific Hake	3.6860	0.0000	0.0000	0.0000
0209	206	1109	Sculpin	.4440	.4440	.4440	.4440
0209	206	1111	Poachers	.1500	0.0000	0.0000	0.0000
0209	206	1112	Lump, Snail Fishes	.4480	0.0000	0.0000	0.0000
0209	206	1199	Other Larvae	13.5180	0.0000	0.0000	0.0000
0210	202	1086	Pacific Herring	4.4080	0.0000	0.0000	0.0000
0210	205	1104	Starry Flounder	2.4880	0.0000	0.0000	0.0000
0210	205	1105	Butter Sole	1.0608	0.0000	0.0000	0.0000
0210	205	1107	English Sole	8.1250	0.0000	0.0000	0.0000
0210	205	1137	Sand Sole	1.2520	0.0000	0.0000	0.0000
0210	205	1140	Slender Sole	9.9350	0.0000	0.0000	0.0000
0210	206	1090	Rockfish	13.9000	13.9000	13.9000	13.9000
0210	206	1093	Pacific Cod	0.0000	0.0000	0.0000	13.1260
0210	206	1094	Ling Cod	.0210	0.0000	0.0000	0.0000
0210	206	1095	Pacific Hake	27.8190	0.0000	0.0000	0.0000
0210	206	1103	Surf Smelt	.0260	0.0000	0.0000	0.0000
0210	206	1109	Sculpin	.5170	.5170	.5170	.5170

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound		(Port 2)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0210	206	1110	Sand Lance	6.9300	0.0000	0.0000	0.0000
0210	206	1111	Poachers	.0950	0.0000	0.0000	0.0000
0210	206	1112	Lump, Snail Fishes	.6230	0.0000	0.0000	0.0000
0210	206	1199	Other Larvae	6.8520	0.0000	0.0000	0.0000

APPENDIX B

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	Species Category	(Port 2) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0201	11	513	Geese	.1600	.0025	0.0000	0.0000
0201	11	515	Diving Ducks	0.0000	.0025	0.0000	0.0000
0201	11	516	Loons	24.0200	0.0000	.4400	7.6900
0201	11	517	Grebes	18.9200	.5500	6.3700	33.2400
0201	13	530	Cormorant	22.3800	.2600	2.5500	14.6000
0201	13	531	Gulls	85.8400	7.3900	25.1900	62.9900
0201	13	533	Terns	0.0000	0.0000	1.3600	0.0000
0201	13	535	Jaegers	0.0000	0.0000	.0025	0.0000
0201	13	537	Storm Petrels	0.0000	.0050	0.0000	0.0000
0201	13	538	Murres	2.7300	.2800	39.2200	31.9500
0201	13	539	Guillemots	.8300	.2900	.3200	.6500
0201	13	540	Puffins	0.0000	.0100	0.0000	0.0000
0201	13	541	Small Alcids (Murrelets,Auklets)	.4650	1.5700	2.1100	1.6500
0201	13	542	Phalaropes	0.0000	0.0000	.2300	0.0000
0202	13	535	Jaegers	0.0000	0.0000	.0025	0.0000
0202	13	537	Storm Petrels	0.0000	.0050	0.0000	0.0000
0202	13	538	Murres	2.7300	.2800	39.2200	31.9500
0202	13	539	Guillemots	.8300	.2900	.3200	.6500
0202	13	541	Small Alcids (Murrelets,Auklets)	.4650	1.5700	2.1100	1.6500
0202	13	542	Phalaropes	0.0000	0.0000	.2300	0.0000
0203	13	538	Murres	.4600	0.0000	8.3800	2.0500
0203	13	539	Guillemots	2.2500	2.0800	2.8000	.5100
0203	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0204	11	513	Geese	0.0000	0.0000	11.2600	0.0000
0204	11	515	Diving Ducks	3.9600	.1500	0.0000	5.6900
0204	11	516	Loons	1.3400	.2400	1.4200	4.1900
0204	11	517	Grebes	11.9100	.1800	16.0400	35.9500
0204	13	530	Cormorant	2.3100	1.5700	2.3900	4.0500
0204	13	531	Gulls	67.8800	100.2300	129.7500	64.5500
0204	13	533	Terns	0.0000	0.0000	.8800	0.0000
0204	13	535	Jaegers	0.0000	0.0000	.0025	0.0000
0204	13	537	Storm Petrels	0.0000	.0050	0.0000	0.0000
0204	13	539	Guillemots	.8300	.2900	.3200	.6500
0204	13	540	Puffins	0.0000	.0100	0.0000	0.0000
0204	13	541	Small Alcids (Murrelets,Auklets)	.4650	1.5700	2.1100	1.6500
0204	13	542	Phalaropes	0.0000	0.0000	.2300	0.0000
0205	13	535	Jaegers	0.0000	0.0000	.0025	0.0000
0205	13	537	Storm Petrels	0.0000	.0050	0.0000	0.0000
0205	13	538	Murres	2.7300	.2800	39.2200	31.9500
0205	13	539	Guillemots	.8300	.2900	.3200	.6500
0205	13	540	Puffins	0.0000	.0100	0.0000	0.0000
0205	13	541	Small Alcids (Murrelets,Auklets)	.4650	1.5700	2.1100	1.6500
0205	13	542	Phalaropes	0.0000	0.0000	.2300	0.0000
0206	13	538	Murres	.4600	0.0000	8.3800	2.0500
0206	13	539	Guillemots	2.2500	2.0800	2.8000	.5100
0206	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0207	13	538	Murres	.4600	0.0000	8.3800	2.0500
0207	13	539	Guillemots	2.2500	2.0800	2.8000	.5100
0207	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0208	13	538	Murres	.4600	0.0000	8.3800	2.0500
0208	13	539	Guillemots	2.2500	2.0800	2.8000	.5100
0208	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0209	13	538	Murres	.4600	0.0000	8.3800	2.0500
0209	13	539	Guillemots	2.2500	2.0800	2.8000	.5100

ZONE 2 - PUGET SOUND, WA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Puget Sound Port & Subzone	(Port 2) Species Category	Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0209	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0210	13	538	Murres	.4600	0.0000	8.3800	2.0500
0210	13	539	Guillemots	2.2500	2.0800	2.8000	.5100
0210	13	541	Small Alcids(Murrelets,Auklets)	.3900	1.9900	4.7300	0.0000
0221	11	513	Geese	147.2500	0.0000	0.0000	0.0000
0221	11	515	Diving Ducks	180.6200	0.0000	1.3600	14.4500
0221	12	561	Herons,Egrets,Bitterns	1.7300	.0500	.6500	.2500
0221	13	531	Gulls	66.5200	21.4300	239.2900	46.0400
0221	13	533	Terns	0.0000	0.0000	1.8900	0.0000
0221	14	582	Bald Eagles	.2300	.1200	.0700	.4700
0222	11	511	Dabbling Ducks	0.0000	4.5200	0.0000	0.0000
0222	11	515	Diving Ducks	585.9200	8.9930	14.4900	60.8450
0222	12	561	Heron	0.0000	.5600	.3200	0.0000
0222	13	531	Gulls	100.2900	25.0800	86.6500	85.4100
0223	11	515	Diving Ducks	15.8400	0.0000	18.3100	35.0600
0223	12	561	Heron	0.0000	0.0000	.0900	1.1700
0223	12	571	Sandpiper,Plover,Turnstone	0.0000	.1400	0.0000	0.0000
0223	13	531	Gulls	34.9400	46.0800	251.4500	35.7600
0223	13	533	Terns	0.0000	50.0000	0.0000	0.0000
0223	14	582	Eagle	.6800	.7200	.1700	0.0000
0224	11	511	Dabbling Ducks	0.0000	.1600	0.0000	114.2500
0224	11	515	Diving Ducks	0.0000	6.6000	75.8200	166.3900
0224	12	561	Heron	0.0000	6.7500	5.2400	0.0000
0224	12	571	Killdeer	0.0000	.7700	.9100	0.0000
0224	12	572	Oystercatcher,Avocet,Stilt	0.0000	0.0000	0.0000	93.3500
0224	13	531	Gulls	0.0000	51.4900	64.9800	22.6900
0224	14	582	Eagle	0.0000	.0400	0.0000	0.0000
0225	12	561	Heron	0.0000	6.7500	5.2400	0.0000
0225	12	571	Killdeer	0.0000	.7700	.9100	0.0000
0225	12	572	Oystercatcher,Avocet,Stilt	0.0000	0.0000	0.0000	93.3500
0225	14	582	Eagle	0.0000	.0400	0.0000	0.0000

APPENDIX C

LOS ANGELES/LONG BEACH, CA

(ZONE 3)

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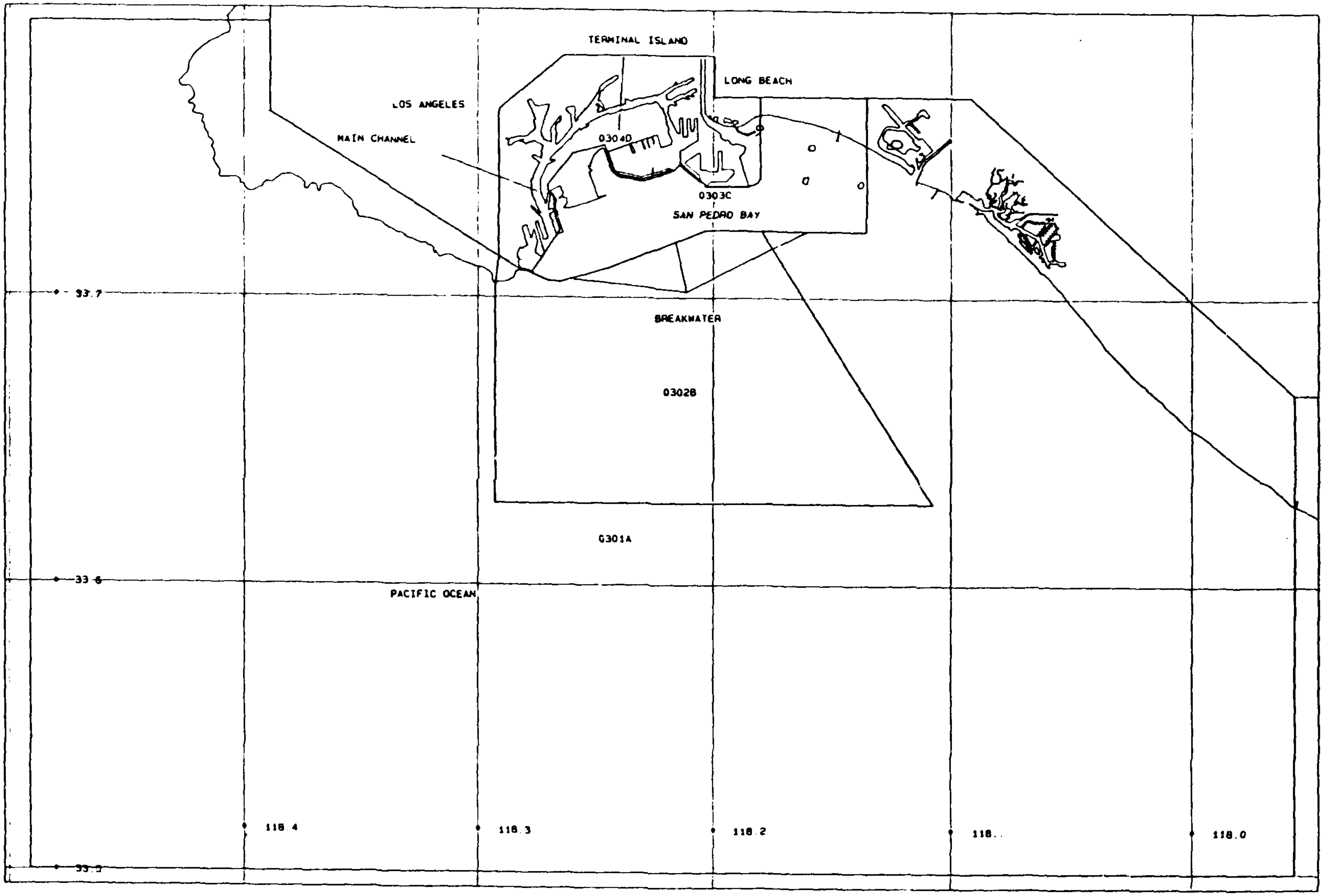
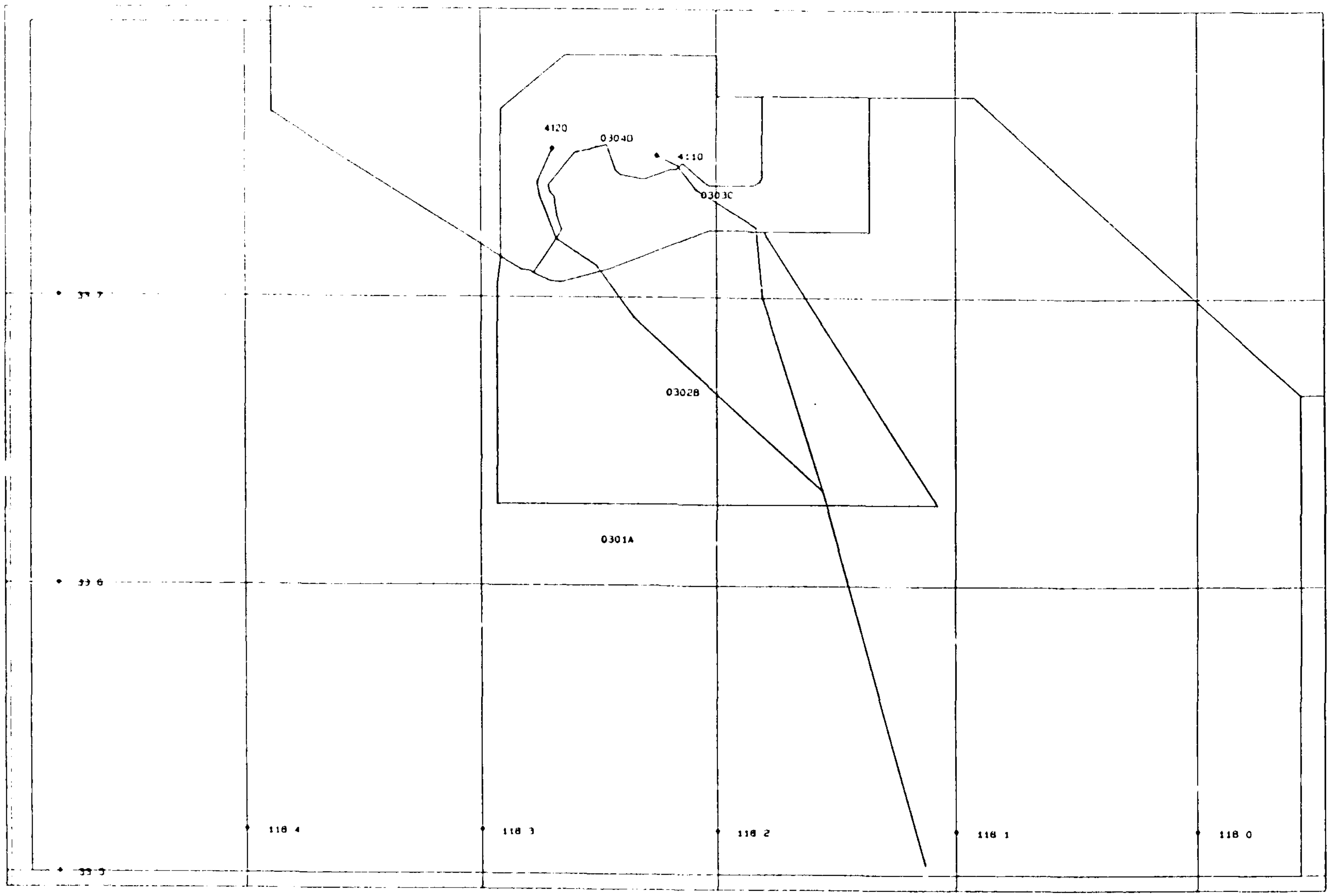
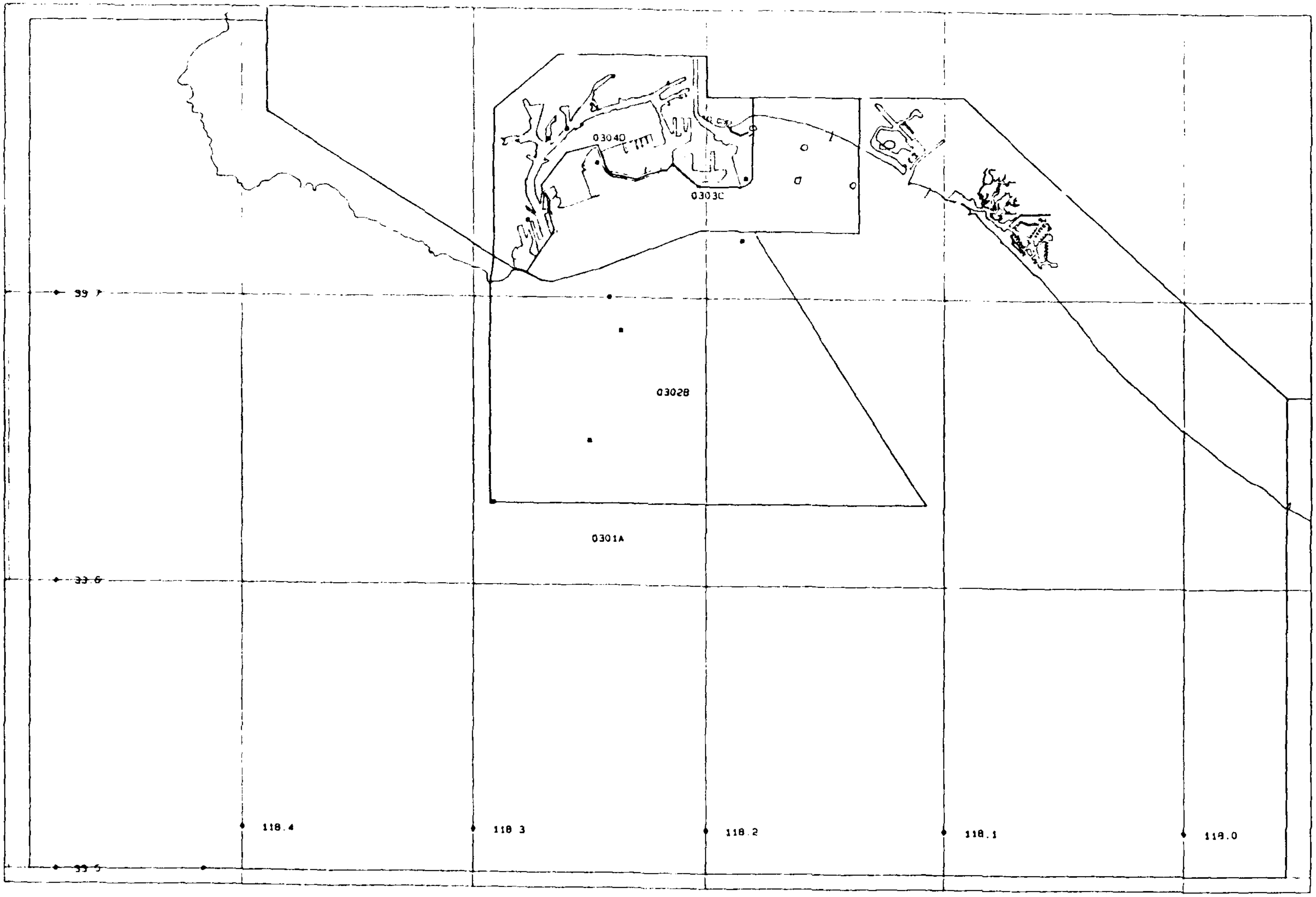
STUDY ZONE MAPS



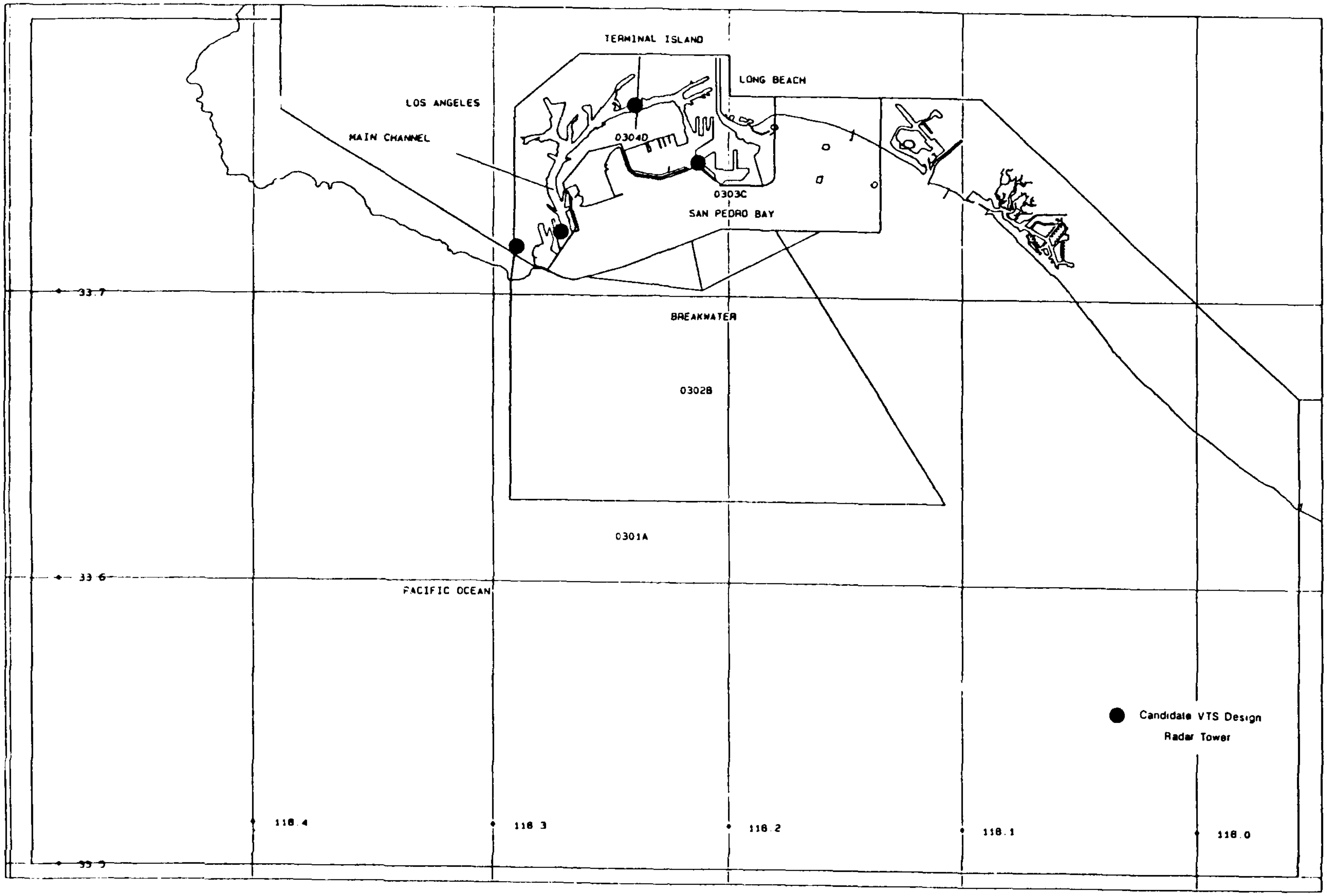
ZONE 3 - LOS ANGELES/LONG BEACH, CA - ZONE AND SUBZONE BOUNDARIES



ZONE 3 - LOS ANGELES/LONG BEACH, CA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 3 - LOS ANGELES/LONG BEACH, CA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 3 - LOS ANGELES/LONG BEACH, CA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

LOS ANGELES/LONG BEACH, CA

(ZONE 3)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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ENCLOSURES

1.0 LOS ANGELES-LONG BEACH PORT SURVEY

1.1 INTRODUCTION

The Los Angeles-Long Beach (LA-LB) port complex is arguably the busiest in the nation and ranks No. 2 worldwide in the number of container twenty-foot equivalent units handled. The ports have a traffic management regime which is functioning well. The operating authorities of both ports are seeking to increase the volume of trade, and the ports have cooperated in the development of an expansion master plan. When the plan is realized, in the year 2020, overall port capacity will be nearly doubled. The expansion project, including its construction phase, will strain the present traffic management system and perhaps exceed its capabilities. The existing system, although effective, may not withstand "after-the-fact" scrutiny in the event of a major marine casualty.

1.2 OVERVIEW OF THE PORT

The ports of Los Angeles and Long Beach represent a busy complex which, with few exceptions, is devoted to maritime commerce. In both ports some recreational activities are intermixed with commercial facilities, but Long Beach has generally devoted more attention to separating the two. With the exception of deeply laden tankers, the area is relatively free of navigation hazards. The weather is benign but there is a prevalence of morning fog, particularly in the spring. Strong winds, called "Santa Anas", periodically cause problems for small craft and high-sided shipping. Commercial fishing activities centered on the complex are not extensive, but there are a large number of pleasure craft moored in and around the harbor.

Although the ports must be treated as a single entity from a traffic management standpoint, significant differences exist in the management of the two. Except for long range planning considerations, little coordination of day-to-day events occurs above the pilot/Marine Exchange level. The ports have a traffic management system which is working effectively, judging by the overall record. The system is "people-dependent", however, and functions well because of the personalities involved. The effectiveness may change as participants do. The chief weakness identified by the Survey Team is that the system has not been formalized and institutionalized. Because of this, it is doubtful that it would withstand rigorous "after-incident" scrutiny. The system is discussed more fully in a subsequent Section.

The management of both ports is dedicated to expanding trade, and have jointly developed a master plan for expansion. Dubbed the "2020 Plan", expansion will approximately double terminal capacity over the next 30 years, and the initial phase is presently underway. The "downside" of the Plan is that most of the Outer Harbor west of a line drawn northward from the west end of Long Beach Breakwater will be lost as a vessel anchorage and transit area. This will impose constraints on ship movement and, unless carefully managed, will impose a queuing problem. The port of Los Angeles has done ship simulator studies of the expansion program based on port design rather than traffic management. No traffic management planning has been done for the expansion.

In addition to container traffic and petroleum products there is a considerable volume of general cargo, including automobiles. The United States Navy transits to and from Long Beach Naval Station are increasing and add another dimension to overall traffic. The port complex is host to extensive facilities, and these are clearly described in the Coast Pilot (Reference 1) and by the National Oceanic and Atmospheric Administration's (NOAA) Port Pollution Response Study. (See Enclosure 1.)

1.3 EXISTING TRAFFIC MANAGEMENT

The Ports of Los Angeles and Long Beach are served by a Vessel Traffic Information Service (VTIS) operated by the Marine Exchange of Los Angeles - Long Beach Harbor, Inc. This service grew out of concern for vessels colliding in the approaches to the ports and the need for passing information and facilitating communications between arriving and departing vessels converging on the breakwater entrances to each port.

The Marine Exchange has for many years kept track of all vessels entering port, keeps their customers informed of arrivals and notifies pilots, tugs, line handlers and other people having business with the ships. The operations center is manned 24-hours a day and a Three-day Advance Arrival Report is published daily. Data on arrivals is kept on cards which are filed after the vessel reaches port.

Communication with vessels normally is conducted on CH 13 and High Frequency Single Sideband radio is available for long range communications.

More recently a Decca marine radar with redundant displays, including a Racal-Decca Model 2690 BT Automatic Radar Plotting Aid (ARPA) raster scan display, has been added. The Marine Exchange utilizes the radar to identify inbound traffic and to advise of traffic conditions particularly in the Precautionary Area.

The Marine Exchange is tied by telephone and dedicated computer "E" mail to the Long Beach and Los Angeles Pilot stations, the U.S. Navy, the Port of Long Beach, and the Coast Guard. The Coast Guard accepts the Marine Exchange's 3-day reports on arriving vessels as the vessel's official arrival notice required by Federal Regulations. Vessel arrival times recorded by the Marine Exchange are utilized by the Longshoreman's Union to set priorities for the allocation of labor to the ships.

Under normal operations, the Marine Exchange attempts to contact all arriving vessels before they reach the Precautionary Area outside the port entrances. This is normally done on CH 13, using the Bridge-to-Bridge radiotelephone frequency. Information on traffic outside and inside the port is relayed to each vessel along with other information attendant to the vessel making port. There are some reports that the Marine Exchange uses CH 13 excessively and passes too much redundant information to arriving vessels, particularly with regard to traffic inside which is of concern to the Pilots. A separate VHF-FM channel should be considered for Marine Exchange operations to preclude the bridge-to-bridge communications system from becoming compromised by Marine Exchange traffic.

By monitoring the pilot frequency and CH 16, the Marine Exchange will frequently facilitate communications between vessels and with the pilots. The Marine Exchange operation has been relocated to property belonging to the U.S. Coast Guard at Fort MacArthur near San Pedro, CA. A second level addition was constructed atop an existing block building at a former gun emplacement. The property is leased to the Marine Exchange at no cost. This has certain Maritime Defense Zone (wartime) implications based upon past history.

Based upon earlier associations between the Long Beach Pilots and the Marine Exchange in addressing vessel traffic monitoring and information, a Port Safety and Navigation Committee was recently formed.

This Committee is chaired by the President of Jacobsen Pilots Service (Long Beach Pilots) and its membership includes the Marine Exchange, U.S. Coast Guard, and U.S. Navy. Part of the motivation for this committee's formation is the proposed requirements for Port Safety Committees contained in a pending California State legislation.

The Port Safety and Navigation Committee have focused their main attention on the Precautionary Area outside the entrances. This area becomes very congested early in the morning when vessels arrive and late in the afternoon as they depart. Traffic from Long Beach crosses through traffic entering and leaving Los Angeles. Container vessels, in particular, rushing against the clock proceed through the Precautionary Area at higher speeds. There have been numerous near misses in the Precautionary Area and several recorded collisions. The Committee has recommended a series of new mandatory rules for the Coast Guard to consider for the Precautionary Area including speed limits, master on the bridge, helm manned, navigation equipment functioning and positive communications on CH 13. These are now being reviewed by the USCG COTP for Los Angeles - Long Beach.

The Los Angeles Pilot station has two conventional marine radars installed to assist pilots on and off the vessels and to manage their anchorages. These systems are far less sophisticated than those at the Long Beach Pilot Station.

The Jacobsen Pilot Service (LB Pilots) has maintained a shore based radar surveillance system for many years - and may have been the first to do so in any U.S. port. Channel 12 (Pilot frequency) communication is performed through a local transceiver located at the Pilot Station or from a High-level site atop San Pedro Hill. The pilot Station does not transmit on CH 13 but does monitor. The pilots report that the U.S. Navy frequently use CH 12 in conducting normal business on hand-held transceivers.

In 1981 the LB Pilot Station radar was upgraded to a Racal- Decca, x-band, 25Kw shipboard type radar with standard ARPA and 9-ft scanner. This provided collision avoidance capability with the shore antenna location serving as "own ship" in the computations which has proven to be of only limited value to the Pilots. The radar is used to manage and vector ships into anchorage and to facilitate the Pilot boat meeting vessels to facilitate transportation.

The anchorages are monitored (automatically) during poor weather and strong wind conditions. They observe traffic in the Precautionary Area but use the information primarily to assist the pilot boats and advise their Pilots. The Pilot station does not provide "traffic management" or "collision avoidance" information except in the form of recommendations to the Pilots onboard.

In 1984, an additional Racal-Decca marine radar, similar to the first, was added. This radar includes an upgraded ARPA with "harbor control" features to permit collision avoidance processing of any three of the 20 targets being tracked. Again, after evaluation, this feature was found to have minimum value to the Pilots in conducting their business. The traffic picture is changing too fast to be able to isolate the proper set of three targets. Extending the "leading lines" of targets and noting intersections has been found to be a more effective way to generate advisory information to the underway Pilots.

During 1989 the Jacobsen Pilot Service installed a third Racal-Decca radar with a Model 2690 BT, 26-inch raster scan, color display and standard ARPA. In addition to a number of improvements of performance and capability, the display has extended features for video mapping and the color presentation simplifies the identification of stationary and moving targets. One particular feature liked by the Pilots is the blue "history trail" (after glow) of a moving target which simplifies the detection and tracking of small targets that could be lost in sea return and noise. Unfortunately, the raster (TV) display does not have the resolution found in non-raster "scopes" and during periods of reduced visibility, the Pilot Station relies upon the conventional radar displays particularly when using the short range scales (down to 1/2 mile) for assisting Pilots into slips.

The Marine Exchange maintains little or no contact with vessel traffic proceeding inside the ports with or without a pilot. Inside, the Long Beach and Los Angeles Pilots (employed by the Port of LA) have their own rules and information system to advise each other of other traffic and to handle any encounters. They sometimes are surprised by meeting traffic which has not announced its intentions or presence on CH 13 and acknowledge there are certain critical navigation areas inside both ports.

Examples are as follows:

(1) In Los Angeles harbor, this includes the Turning Basin north of the Vincent Thomas Bridge and the East Basin intersection of the Cerritos Channel and the Consolidated Slip.

(2) In Long Beach, the Back Channel restrictions at the Desmond Bridge and the Middle Harbor area just inside the inner breakwater are of concern to the Pilots.

Both Pilot organizations have considered local radar scanners to watch these areas and certain dock facilities to assist them during low visibility. Local radar surveillance will become more important with the implementation of the 2020 Plan.

The Port Warden in the Port of Los Angeles maintains on-the-water patrols and enforces Port of Los Angeles Tariffs, Coast Guard COTP Orders and other Regulations. There is no similar organization in Long Beach harbor and USCG enforcement is handled directly by the Coast Guard.

The various entities in the ports have varying opinions on the degree of vessel traffic service that is being provided now. While the Marine Exchange believes they are already operating a "vessel traffic system" with highly trained watch personnel, etc, the Pilots recognize that although the Exchange provides a necessary service, there are issues of liability and enforcement that separate the Marine Exchange from true vessel traffic management. The Pilots are not interested in the Coast Guard controlling traffic inside the ports but see the need for positive control and enforcement outside particularly in the Precautionary Area. The general indications are that the Port Safety and Navigation Committee would somehow like to see the existing elements now dealing with traffic management in the ports brought together under the umbrella of the Coast Guard.

1.4 VESSEL TRAFFIC

In 1989 LA-LB experienced approximately 20 arrivals and 20 departures per day. These tend to occur in blocks of time-- inbound during the period 0500-0800; and outbound, from 1600 to 1800. The schedule is dictated by the working day of the longshoremen.

Although the emphasis is upon container traffic, Long Beach is rated by the Center for Marine Conservation as the 8th busiest port in the U. S. from the standpoint of moving crude oil. The combined ports have a heavy schedule of tank ships and petroleum product barges. The 1987 movement statistics provide a good indication of the overall volume of petroleum-related traffic.

Type Vessel	In	Out
Tank Ship	1986	1985
Barges	5393	5393

1.5 ENVIRONMENTAL SENSITIVITY

A recent study accomplished under the auspices of the National Oceanic and Atmospheric Agency (NOAA) has examined the combined ports of Los Angeles-Long Beach from an environmental perspective. Extracts from that study are included as part of Enclosure (1).

1.6 PORT SUB-ZONES

The harbor area was examined to determine appropriate Sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 2).

Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

Four distinct sub-zones were identified.

1.6.1 Sub-Zone I - Los Angeles-Long Beach Precautionary Area. (NOAA Chart 18746)

Sub-Zone I consists of that portion of San Pedro Bay enclosed by the Precautionary Area established by 33CFR161.187.

The Precautionary Area is classified as "confined-complex." Ship movement is confined because of the proximity of the breakwater, the pilot pick-up areas and the anchorage area lying between the two entrances.

72COLREGS apply throughout the Precautionary Area. When the current Long Beach Channel dredging project is completed, Precautionary Area depths will be less than the Outer Harbor channel depths.

1.6.2 Sub-Zone II - Los Angeles-Long Beach Outer Harbor. (NOAA Chart 18751)

Sub-Zone II consists generally of those portions of the ports of LA-LB which lie between the breakwater and the entrances to the inner harbors. The demarcation lines are: In Los Angeles, a line drawn between Reservation Point Light and the Los Angeles Pilot Station; and in Long Beach, between Navy Base Mole and the Long Beach Pilot Station. The eastern limit of the sub-zone is a line drawn due north from the east end of Long Beach Breakwater.

The Sub-Zone is classified as "confined-complex". Ship movement is confined by other activities and, except in the channels, there is no pattern to traffic flow. Inland Rules of the Road apply throughout, with the Demarcation lines being the breakwater entrances. Water is generally good throughout, and there is an absence of navigational hazards except for heavily laden tankers entering Long Beach. Such ships are confined to the Long Beach Channel or to anchorages C-13, C-13, and C-14.

The sub-zone is heavily used by ancillary traffic, such as bunkering barges, and pleasure crafts.

1.6.3 Sub-Zone III - Los Angeles Inner Harbor. (NOAA Chart 18751)

The Sub-Zone consists of that portion of Los Angeles Harbor inside the demarcation line between Reservation Point Light and the Los Angeles Pilot Station. Its eastern limit is in Cerretos Channel at the Heim Bridge.

The Sub-Zone is classified as "confined-complex. Ship movement is confined by channel limits, and by the presence of moored ships. Traffic flow of commercial shipping is predictable along the channel axis but movements of pleasure craft, fishing vessels and tug traffic introduces randomness.

Inland Rules of the Road apply throughout.

1.6.4 Sub-Zone IV - Long Beach Middle and Inner Harbors. (NOAA Chart 18751)

The Sub-Zone consists of those portions of Long Beach Middle and Inner Harbors inside the demarcation line between Navy Base Mole and the Long Beach Pilot Station. Its western limit is in Cerretos Channel at the Heim Bridge.

The Sub-Zone is classified as "confined-complex. Ship movement is confined by channel limits, and by the presence of moored ships. Traffic flow of commercial shipping is predictable along the channel axis but movements of pleasure craft, fishing vessels and tug traffic introduces randomness. Middle Harbor maneuvering is constrained by the presence of a Restricted Area north of the Navy Base Mole.

Inland Rules of the Road apply throughout.

1.7 PROBLEM AREA IDENTIFIERS

1.7.1 PAI I-1. Precautionary Area. (NOAA Chart 18749)

The Precautionary Area represents the single most hazardous portion of the port complex. During the early morning period there is frequently a rush to enter the breakwater, since passage through the breakwater determines the order in which longshoremen gangs are assigned.

Because of the limited number of pilots, and the fact that as many as 20 ships can arrive off the port within hours of each other congestion is a major concern. Upon departure ships bound from Long Beach to the Barbara Channel cross the Los Angeles entrance at right angles.

There are also anchorages located in the Precautionary Area, and there can be considerable small craft activity. All parties interviewed identified this as a prime area of concern.

1.7.2 PAI II-1. LA-LB Outer Harbor. (NOAA Chart 18751)

Port development plans are affecting activities in and adding to the congestion of the Outer Harbor. Construction, dredging, filling and the like will intensify over the next 30 years until completion of the "2020 Plan."

Anchorage management for maximum draft ships such as a Very Large Cruise Carrier, is already critical, since only one area accommodates them when laden. The anchorage area is also used extensively for bunkering. While there are an ample number of anchorages available now, the various phases of the "2020 Plan" will progressively reduce these until at completion only the "A", "D", "E" and "K" areas will remain (and some of those anchorages will be lost as well). A combination of small craft activity, ship movement, bunkering and ships at anchor frequently makes the Outer Harbor congested. Forecasts or existence of high and/or gusty winds can affect decision to move high-sided ships into the inner harbors.

1.7.3 PAI III-1. LA Main Channel. (NOAA Chart 18751)

Existing pilot rules prevent meeting of ships at the bend of the LA Main Channel in order to insure ample turning room.

1.7.4 PAI III-2. LA Turning Basin. (NOAA Chart 18751)

Ships inbound to the East or West Basins must use the Turning Basin for maneuvering. Other traffic must be held outside of the area until maneuvers are complete.

1.7.5 PAI III-3. LA East Basin Channel. (NOAA Chart 18751)

With ships alongside berths the East Basin Channel is very difficult. There is no room for meeting and ships cannot transit while bunkering barges are alongside moored ships. Traffic must be constrained to a "one-way" pattern.

1.7.6 PAI IV-1. LB Back Channel, Channels 2 & 3. (NOAA Chart 18751)

The area is sufficiently confined to require that ships not meet within it, and movements must be scheduled to prevent hazardous conditions from developing.

1.7.7 PAI IV-2. LB Middle Harbor. (NOAA Chart 18751)

The Navy Base Mole entrance can be difficult, depending upon ship characteristics and conditions. Speed is regulated by City Ordinance and outbound ships have precedence. Traffic must be regulated to prevent meeting and the need for evasive maneuvering.

1.8 VTS CONCEPTS AND ASSUMPTIONS

Although traffic densities are generally low in relation to the expanse of water involved, and the potential for interaction between deep-draft ships is therefore low, a number of arguments support the need for strong traffic management. Chief of these relates to public concern with and acceptance of the continuing movement of petroleum products by water.

a. The technical and decision support design should address the following basic concepts:

(1) Communications is the backbone of any VTS.

(2) Effective Vessel Traffic Management includes enforcement rules and regulations affecting waterway safety and which facilitate marine transportation through the port.

(3) VTS operation and management should be based upon minimizing people-intensive procedures and commitment.

b. Information from remote sensors should as practicable:

(1) Permit management of information by exception;

(2) Be relayed in the most cost effective way;

(3) Be available on as "as required" basis; and

(4) Require minimum processing by people.

1.9 THE DESIGN BRIDGE

Traffic Management Requirements, VTS Design Implications and VTS Technology Areas are utilized to form a bridge between the PAI descriptions and VTS design. Table 2-1 depicts this process in tabular form.

a. Management Requirements

These are developed from PAI analysis and reflect the basic needs for effectively managing vessel traffic in each PAI.

Common to all PAIs are the needs for "appropriate regulations" and "the ability to communicate". Therefore, these are not separately identified in Table 2-1 The Management Requirements are listed alphabetically for each PAI and no inference as to importance should be concluded from their listing order.

TABLE 2-1. PROBLEM AREA IDENTIFIERS

PAI#	LOCATION	PROBLEM/POTENTIAL PROBLEM	MANAGEMENT REQUIREMENT	VTS DESIGN IMPLICATIONS
I-1	Precautionary Area	Congestion, risk of collision, queuing, excessive speed	Advise shipping of activities. Appropriate traffic regulations. Enforcement of rules. Knowledge of ship movements. Ability to fix positions of ships at anchorage. Ship characteristics database. Ship movement database. Up-to-date weather information.	Radar
II-1	Outer Harbor	Congestion, risk of collision, anchorage activities management	Advise shipping of activities as appropriate. Ability to fix positions of ships in anchorage. Enforcement of rules. Appropriate regulations. Ships characteristics darabase. Ships movement database. Navigation assistance during periods of low visibility, non-availability of pilots and Up-to-date weather information.	Radar
III-1	LA Main Channel	Meeting at turn	Appropriate regulations. Enforcement of rules. Knowledge of ship movements. Ship movement database.	Radar
III-2	LA Turning Basin	Congestion,meeting in narrow waterway or while maneuvering	Appropriate regulations. Enforcement of rules. Knowlege of ship movements. Ship movement database.	Radar
III-3	LA East Basin Channel	Congestion,meeting in narrow waterway or while maneuvering	Appropriate regulations. Enforcement of rules. Knowlege of ship movements. Ship movement database.	Radar
IV-1	LB Back Channel, Channels Two and Three	Congestion,meeting in narrow waterway or while maneuvering	Appropriate regulations. Enforcement of rules. Knowlege of ship movements. Ship movement database.	Radar
IV-2	LB Middle Harbor	Congestion,meeting in narrow waterway or while maneuvering, excessive speed.	Appropriate regulations. Enforcement of rules. Knowlege of ship movements. Ship movement database.	Radar

b. VTS Design Implications

CH13 and VTS communications. All PAIs must be covered by effective communications. This most likely would include one or more additional VHF-FM Channels dedicated to VTS operations and one or more channels for communications with the pilots. Because this requirement exists for all PAIs, it is not shown in the Table 2-1.

Radar Surveillance. PAIs III-1 and IV-1 should be covered by radar surveillance. This should be interpreted to mean the ability to observe vessel traffic, including small recreation and fishing boats, with sufficient resolution to differentiate between large and small target. The radar should have range scales adequate to cover the entire area of interest and preferably overlap with radar coverage in adjacent PAIs. For PAI III-1, the radar could be located atop the Los Angeles Maritime Museum building (former Ferry Building) and for PAI IV-1, the radar could be located on the north side of Gerald Desmond Bridge crossing the Back Channel.

One radar located at the Marine Exchange in San Pedro could serve the requirements for PAI I-1 and the Los Angeles portion of PAI II-1. This radar should have a maximum range scale of approximately 50 miles. A radar located on the Berth 151 tower (former Catalina Terminal) could serve the requirements for PAI III-2 and III-3.

The radar requirements for PAI IV-2 and the Long Beach side of PAI II-1 are presently being fulfilled by the Jacobsen Pilot Services, Racal Decca radar located at the "knee" between Piers A and F in Long Beach harbor.

Meteorological Information. Where required, this should be remote sensors for wind, fog, and temperature with data sent to the Vessel Traffic Center via telephone lines.

Vessel Traffic Center. Appropriate numbers of database management - decision support work stations and suitable displays (raster scan - radar and CCTV and data) are required to support the remote sensors and communications equipment.

2.0 LA/LB HARBOR VTS DESIGN

2.1 INTRODUCTION

A detailed survey of LA/LB Harbor is the basis for this design. A new approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a new method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The four sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified and the casualty history in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

2.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- Percentage of vessels of the desired minimum size detected in designated surveillance areas
- Percentage of lost tracks
- The accuracy of the position and track obtained
- The reliability of the surveillance system
- The timeliness of the data obtained

- The ability to interpret and use the data obtained

Secondary criteria are:

- Cost of the VTS system -- reduction of manpower by the use of technology

- Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore (ADS). The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- The number and class of vessels which interact in this sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may effect all the VTS designs for all the other sub-zones in all the other harbors.

2.1.2 Assumptions

The design of a VTS system for the LA/LB harbors starts with a set of assumptions based on the detailed port survey and other data. These assumptions are as follows:

o The weather is excellent; heavy rain is rare. There is occasional morning fog and seasonal Santa Ana winds. Strong southwest winds occur almost every afternoon.

o The traffic is not extremely dense; at present only twenty ships a day enter and exit the ports.

o Compared to other ports of this size the accident rate is these harbors is small.

o Current procedures in these ports has created morning and evening traffic cluster in the precautionary area.

o These side-by-side ports are relatively compact. The entire area inside the breakwaters is less than six miles by six miles.

o Very large oil tankers enter Long Beach Harbor and there is a significant volume of container traffic.

o There is not an extensive commercial fishing fleet.

o There are commercial ferry routes from both harbors to Catalina Island. The ferries leave regularly during the day via both channels.

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system must be implemented with the cooperation and assistance of the Port Authorities, Marine Exchange and the pilots associations. The existing facilities and services operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

2.2 DESIGN DECISIONS

2.2.1 General

The facts contained in the port survey lead to the following broad design decisions:

o The precautionary area and its approaches must be actively monitored and vessels must be advised of impending problems. The distances involved and accuracies required call for narrow beam width radar.

o Radar surveillance of the outer harbor is required to monitor the interaction of traffic in the anchorages and track vessels entering and leaving both harbors.

o Radar surveillance of the inner harbor channels and turning basins is required to avoid untenable meeting situations between large vessels in low visibility and between large vessels and unexpected vessels (tugs, etc.) at any time.

o Three control sector presentations are adequate for VTS monitoring if a high level, interactive software program is used. These are: 1) the precautionary area and outer harbor, 2) the LA inner harbor, and 3) the LB inner harbor.

o Separate communications channels are needed; one channel to serve Sector 1 and one channel to serve Sector 2 and 3.

o To keep total cost within the context of the existing VTS problem and casualty history for this port, the design hardware should make use of existing facilities and employ modern hardware and software techniques that can reduce manning levels. This concept allows a VTS control center to be manned by two people. One person monitors all sectors and the other acts as a supervisor except during periods of heavy traffic (0500 to 0800 and 1600 to 1800). During these periods one watchstander monitors Sector 1 and one watchstander/supervisor monitors Sectors 2 and 3.

A summary of the surveillance chosen for the LA/LB VTS zone is contained in Figure 2-1. Figure 2-2 represents the system design in block diagram form.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I			1							1	1	2				1			
II			1							2			1						
III										2			1		1				
IV																			

FIGURE 2-1. LA/LB, CALIFORNIA, HARBOR SURVEILLANCE SURVEY

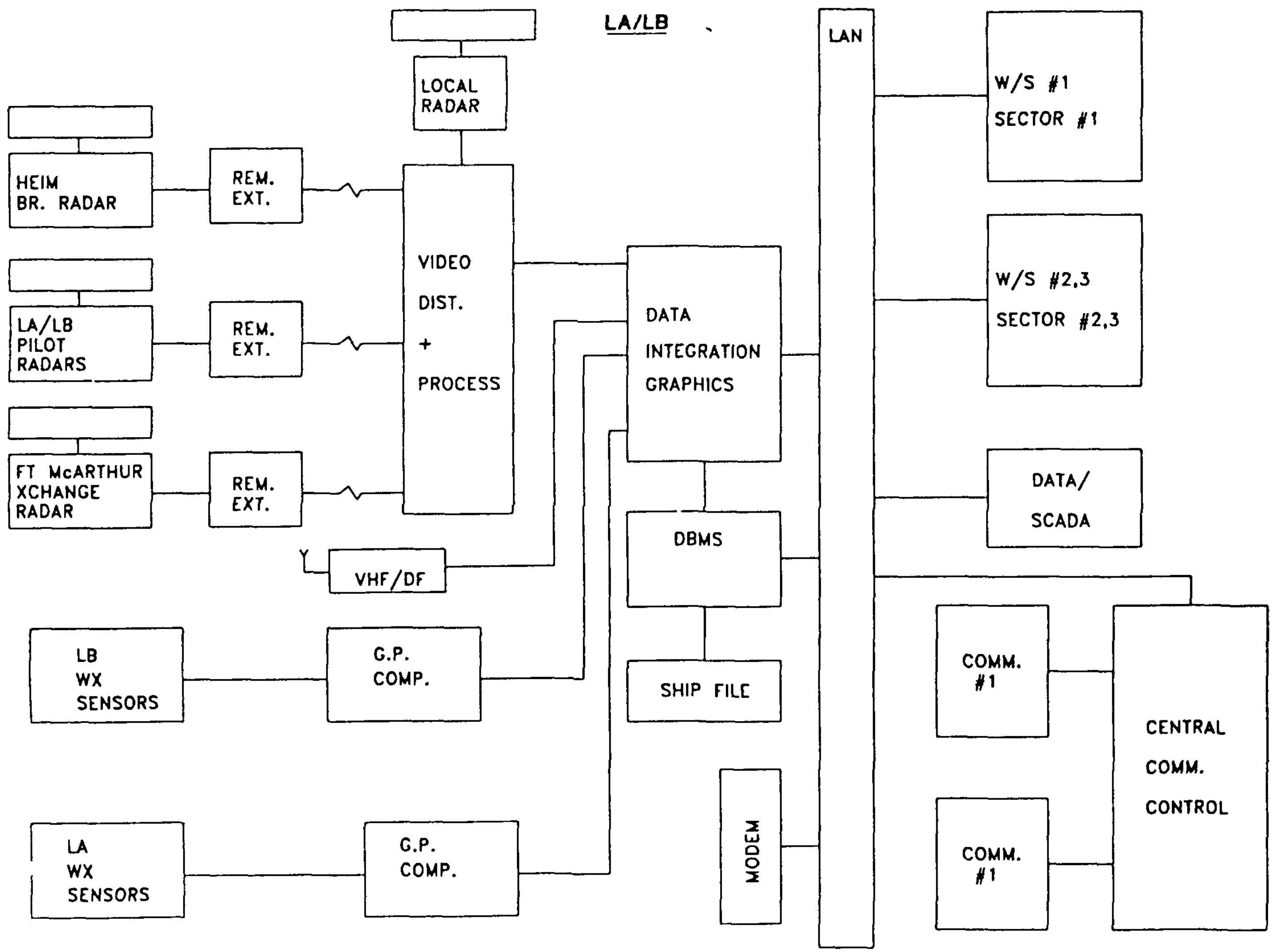


FIGURE 2-2. LA/LB, CA, VTS DESIGN BLOCK DIAGRAM

2.2.2 Sub-zone I -- LA/LB Precautionary Area

2.2.2.1 Discussion

This area of approximately 50 square miles is the intersection of two main traffic separation schemes bringing ships to these ports. The major problem in this area has been identified as the crossing patterns set up by vessels going to one port or the other from either the northern or southern traffic lanes. Figure 2-3 is a diagram of the existing crossing patterns. There are eight possible crossing situations of which six are created by Long Beach traffic coming from or going to the northern traffic lanes. Half of the total crossing situations occur near the entrance to Los Angeles Harbor. Vessels moving between Long Beach and the northern traffic lanes (these include the Alaskan pipeline tankers) therefore need extra surveillance. Anchorage G is in this area and also requires monitoring because of the random traffic patterns.

This area lends itself to use of a vessel-based surveillance system if it becomes necessary to have more data on vessels headed for these harbors. There are no serious port planning problems now other than the vessel bunching caused by local procedures. If, however, a national or international requirement emerges for the carriage of ADS devices on deep draft vessels, this sub-zone represents one area where such data could be employed. Since this area is well outside of the harbor pilots' ship boarding stations, a carry-on type of ADS device is impractical.

2.2.2.2 Design

Active radar surveillance is chosen for this entire area because of the current traffic patterns involving difficult crossing situations combined with bunching in the morning and evening. Complete overlapping communications coverage is provided by the high radiated power level sites combined with the distributed low power level sites. This communications implementation reduces interference and confusion between sectors. A VHF/DF capability is added to aid in vessel identification. This direction finding capability is required because of the occasional vessel bunching which causes vessel identification problems when using radar alone. Procedural improvements in the form of entry and exit control, are needed and an organized queuing scheme must be developed to reduce accident risk. A visibility sensor and an anemometer is to be placed at the LA and LB breakwater entrances to collect meteorological data. This data is necessary to provide ships with the actual weather conditions in the entrance channels.

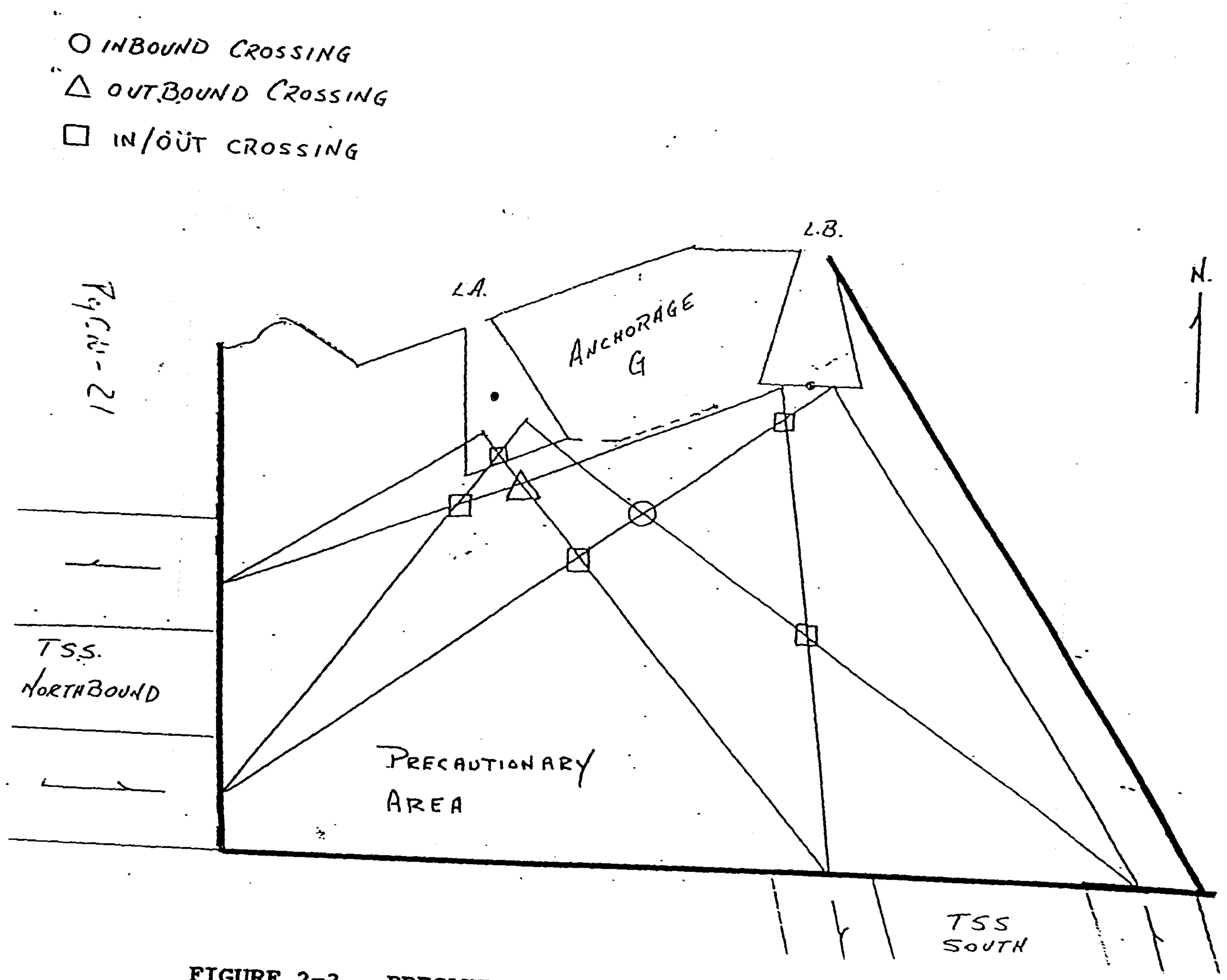


FIGURE 2-3. PRECAUTIONARY AREA-CROSSING PATTERNS

Specific hardware selected is:

- o A new Module 3 radar installation on U.S. Coast Guard property at Fort MacArthur. Move the existing radar at the marine exchange to the LA pilot station to replace its older radar. A Module 3 radar is selected because the distances involved and the target bunching require a small resolution cell.

- o Utilize extracted radar data from existing radars at the LA/LB pilot stations. These equipments will in no way alter the existing data used by pilots. Extracted data from these radars are to be transmitted to the vessel traffic center by telephone line.

- o A Module 16 VHF/DF installation at Fort MacArthur.

- o VHF Modules 10 and 11 installations at Fort MacArthur. Minimum frequency capability includes Channel 16, Channel 13, Channel 77 (tug channel), and Channel 74 (pilot channel) and the two VTS frequencies.

- o A meteorological Module 12 installation at the east end of the San Pedro breakwater.

- o A meteorological Module 12 installation at the east end of the middle breakwater.

2.2.3 Sub-zone II -- LA/LB Outer Harbor

2.2.3.1 Discussion

The major features of this area are the LA/LB entrance channels, the west channel in LA, the southeast basin in LB, and the C anchorages. The combination of channel-confined traffic and haphazard traffic in the anchorage requires radar surveillance. The Los Angeles and Long Beach pilot station radars presently provide excellent overlapping coverage of this area. Since piloting assistance is not to be furnished by the VTS (only traffic advisory information), extracted target data can be utilized. Target data can be extracted from one or both of these radars without interference of their intended function. This zone requires no specific meteorologic or hydrologic sensors since it is covered by the sensors in sub-zone I. Ship movements in Anchorage C should be the subject of additional procedural rules because several anchorages are utilized by supertankers.

Dependent surveillance type systems are not recommended in this sub-zone for several reasons. To provide monitoring of the pertinent vessel interactions, all three classes of vessels down to 20-meters, i.e. oceangoing, coastal, and local, would have to be equipped. In addition, the random traffic interactions in Anchorage C must be carefully monitored, and, finally, a fail safe back-up would be required.

2.2.3.2 Design

VTS surveillance for this area is total active radar and communications coverage. The radar coverage is furnished by the new surveillance radar at Fort MacArthur (see Sub-zone I) supplemented by the data from the pilot station radars. Communications coverage is provided from Fort MacArthur and the low level sites at each pilot station (see Sub-zones III & IV).

2.2.4 Sub-zones III and IV -- LA/LB Inner Harbors

2.2.4.1 Discussion

These two "confined complex" sub-zones are identical in that they both have narrow channels, one-way traffic areas, and a requirement for careful management of ship movements. They have been placed in separate control sectors because of the differing procedural rules created by the two municipalities involved.

Radar surveillance of these areas is necessary to detect movements of unscheduled vessels such as tugs and barges and to monitor movements of the larger vessels. The Los Angeles pilots station radar does not provide adequate coverage from the pilot station to the Vincent Thomas Bridge because of its physical location. It must be replaced with a modern radar and elevated for a better view of the main channel. The Long Beach pilot station radar provides adequate coverage from the pilot station to the Desmond Bridge, including the West Basin. Surveillance in the LA/LB inner harbors requires a new radar with a small resolution cell (high azimuthal and range resolution) because of the narrow channel dimensions. The LA turning basin and the LB inner harbor need visibility and wind sensors to detect dangerous localized visibility and wind conditions. A complete meteorological and hydrological sensor capability is needed due to maneuvering difficulties caused by varying currents, winds and visibility in the vicinity of the LB pilot station.

An ADS system is inappropriate because it would be necessary to equip all types of vessels. The most serious concern in this sub-zone is surprise or unannounced vessel movements.

2.2.4.2 Design

Specific hardware selected is:

- o A Module 10 VHF facility at the LA/LB pilot stations, the LA turning basin and the LB turning basin.

- o A Module 3 radar facility in the vicinity of the Heim Bridge located so that neither the Heim nor the Schuler Bridges cause significant radar shadowing of water areas.

- o A Module 13 meteorological facility at the LA and LB turning basins.

- o A Module 13 meteorological facility and a Module 15 hydrological facility at the Long Beach pilot station.

2.2.5 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. Two watchstanders with integrated data workstations and decision aiding software can effectively manage the activity in these ports. This Vessel Traffic Center concept demands that the watchstanders be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is to be located at Fort MacArthur in a location with good visual surveillance of the precautionary area and the outer harbor. The center is to employ the following equipment:

2.2.5.1 VTS console

This console provides total data integration from all sensors in both sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

o Software providing the total integration of data from all VTS sensors.

o Layering of data in at least four layers to be operator selectable.

o The ability to sector data including sector to sector handoff of targets.

o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy

o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor to be provided. Additional warning and/or alarm features allowed by programming changes in high level language.

o Complete modern color graphics capability with offset and zoom

o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

2.2.5.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

2.2.5.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

2.2.5.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

2.3 COST ESTIMATES

2.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Los Angeles/Long Beach VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 2.1.2. The Appendix estimates the cost savings derived from using existing systems.

2.3.2 Hardware

Vessel Traffic Center	(x $1000) Non-recurring	(10-yr)
VTS Console (w/all software)	$ 750	
Comms Console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	100	
SUB-TOTAL	$1000	500

Sector 1		
2 ea. Radar video processors (Pilot stations)	400	400
1 Module 3 Radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
2 Module 12 Met	40	10
1 Module 16 DF	90	5
SUB-TOTAL	$ 997	$848

Sectors 2 and 3		
1 Module 3 Radar	400	400
1 Module 10 VHF	76	52
2 Module 13 Met	80	10
1 Module 15 Hyd	50	5
SUB-TOTAL	$ 606	$ 467

Total Hardware Costs		
VTC	$1000	$ 500
Sector 1	997	848
Sector 2 and 3	606	467
TOTAL:	$2603	$1815

2.3.3 Total Project Costs (x$1000)

Hardware	$2603
Management, Engineering, etc.(60%) Assumptions: Turnkey system, Procurement by integ.contractor, System Manual required	1562
Installation, site integration (20%) Assumptions: Complete installation by contractor, remote access no problem	520
Spares & Training (10%)	260
Civil Engineering (77%) Assumptions: Building modification at Fort MacArthur, Comms tower, remote radar building	2000
PROJECT ESTIMATE:	$6945
Data Base Management System*	300
TOTAL: (Non-recurring)	$7245

<u>10-Year O&M Recurring</u>

Hardware	$1815
2 watchstanders x 5 = 10 man/years @ $50K/yr	5000
1 Officer-in-charge @ $50K/yr	500
1 Clerk @ $50K/yr	500
DBMS maintenance @ $10K/yr	100
TOTAL O&M (10-yr. life)	$7915
TOTAL 10-Yr. PROJECT COST	$15160

REFERENCES

1. Unites States Coast Pilot, Pacific Coast: California, Oregon, Washington, and Hawaii, 25th Edition, NOAA, Washington, D. C.

2. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

COST SAVINGS DERIVED USING EXISTING
SURVEILLANCE EQUIPMENT

LOS ANGELES/LONG BEACH (Including New Radars for Pilot Stations)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console with all software	750	
Comms Console	100	
Recording Equipment	50	
SCADA Equipment (10 radar sites)	100	
Sub-total:	1000	500
Sector 1		
2 Module 1 radars	620	620
1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
2 Module 12 MET	20	10
1 Module 16 DF	90	5
Sub-total:	1217	1068
Sector 2 and 3		
1 Module 3 radar	400	400
1 Module 10 VHF	76	52
2 Module 13 MET	80	10
1 Module 15 HYD	50	5
Sub-total:	606	467
TOTAL HARDWARE COSTS:	2823	2035

Los Angeles/Long Beach (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

Hardware	$2823
Management, Engineering, etc. (60%) Assumptions: Turnkey system, Procurement by integ.contractor, System Manual required	1694
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no problem	565
Spares & Training (10%)	282
Civil Engineering Assumptions: Building modification at Fort MacArthur, Comms tower, remote radar building	2000
PROJECT ESTIMATE:	7364
Data Base Management System	300
TOTAL: (non-recurring)	$ 7664

2.2 RECURRING (10 YEAR)

Hardware	2035
2 Watchstanders x 5 = 10 man/years @ 50K x 10	5000
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 8135
TOTAL 10-YEAR PROJECT COST:	$15799

Comments:

1. Includes 2 new radars at pilot stations.
2. Non-recurring cost in original report should be $11935. Total should be $23670.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I			1							1	1	2				1			
II			1							2			1						
III										2			1		1				
IV																			

LA/LB, CALIFORNIA, SURVEILLANCE SURVEY

ENCLOSURE 1
EXTRACTS FROM NOAA
PORT STUDY

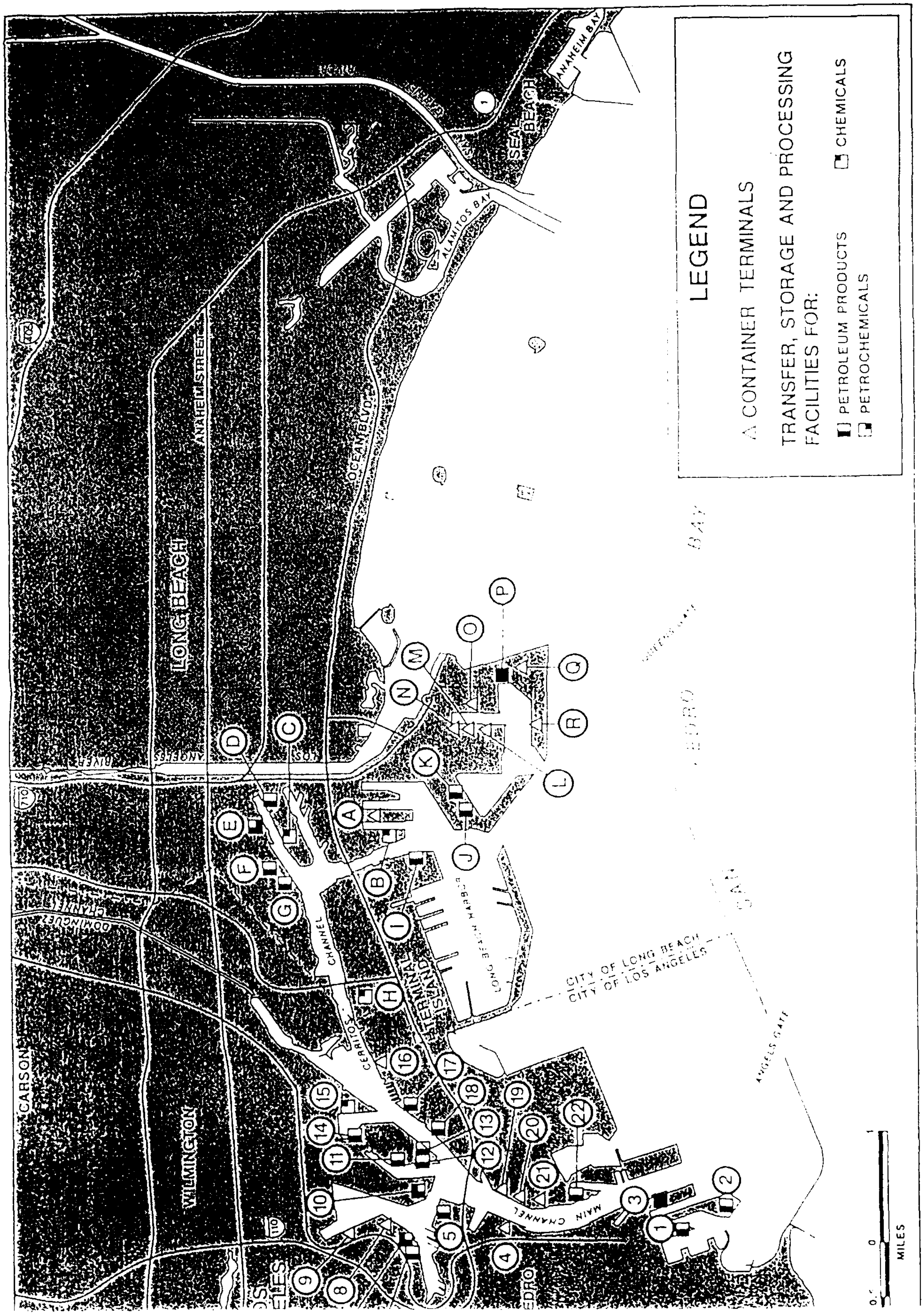

LEGEND
A CONTAINER TERMINALS
TRANSFER, STORAGE AND PROCESSING FACILITIES FOR:
PETROLEUM PRODUCTS
PETROCHEMICALS
CHEMICALS
LONG BEACH
WILMINGTON
CARSON
SEAL BEACH
ALAMITOS BAY
ANAHEIM BAY
ANAHEIM STREET
OCEAN BLVD.
TERMINAL ISLAND
CERRITOS CHANNEL
MAIN CHANNEL
LONG BEACH HARBOR
CITY OF LONG BEACH
CITY OF LOS ANGELES
ANGELS GATE
MILES

TABLE 1. Index to facilities which handle hazardous materials and petroleum products.

Facility Identification Number/Letter	Facility	Berth Number
Port of Los Angeles		
1	U.S. Navy Fuel Wharf	37-40
2	Union Oil Company Bulk Terminal	45-47
3	GATX	70, 71
4	Korea Shipping Terminal	89-92
5	Chevron USA, Inc.	97, 98, 101, 102
6	GATX	118, 199
7	BP North America Trading, Inc.	120
8	American President Lines, Ltd.	121, 126
9	LA Container Terminal	127-129
10	Union Oil Company	148, 149
11	Chevron Chemical Company	163, 164
12	Shell Oil Company	167-169
13	GATX	171-173
14	Los Angeles Dept. of Water and Power	180-181
15	Wilmington Liquid Bulk Terminals, Inc.	187-189
16	Matson Terminals, Inc.	206-209
17	BP North America Trading, Inc.	215
18	Refiners Marketing Company	216-225
19	Overseas Shipping Company	228-230
20	Marine Terminals Corporation	231-223
21	Evergreen Marine Corporation	233-236
22	Mobil Oil Corporation	237, 238, 240
Port of Long Beach		
A	California United Terminals	17, 18
B	Metropolitan Stevedore	29-31
C	Procter and Gamble Manufacturing Company	69
D	Powerine Oil Company	73
E	Atlantic Richfield Company	76-80
F	Long Beach Terminal Company	82, 83
G	Texaco, Inc.	84-87
H	Dow Chemical, USA	101
I	Atlantic Richfield	121
J	Exxon Company, USA	209
K	C. Brewer Terminals	210
L	Sea-Land Service	227-228
M	Maersk Line Agency	229

TABLE 1. Continued

Facility Identification Number/Letter	Facility	Berth Number
N	United States Lines	230
O	International Transportation Service	232-234
P	C. Brewer Terminals	242
Q	Long Beach Container Terminal	243-244
R	Pacific Container Terminal	245-247

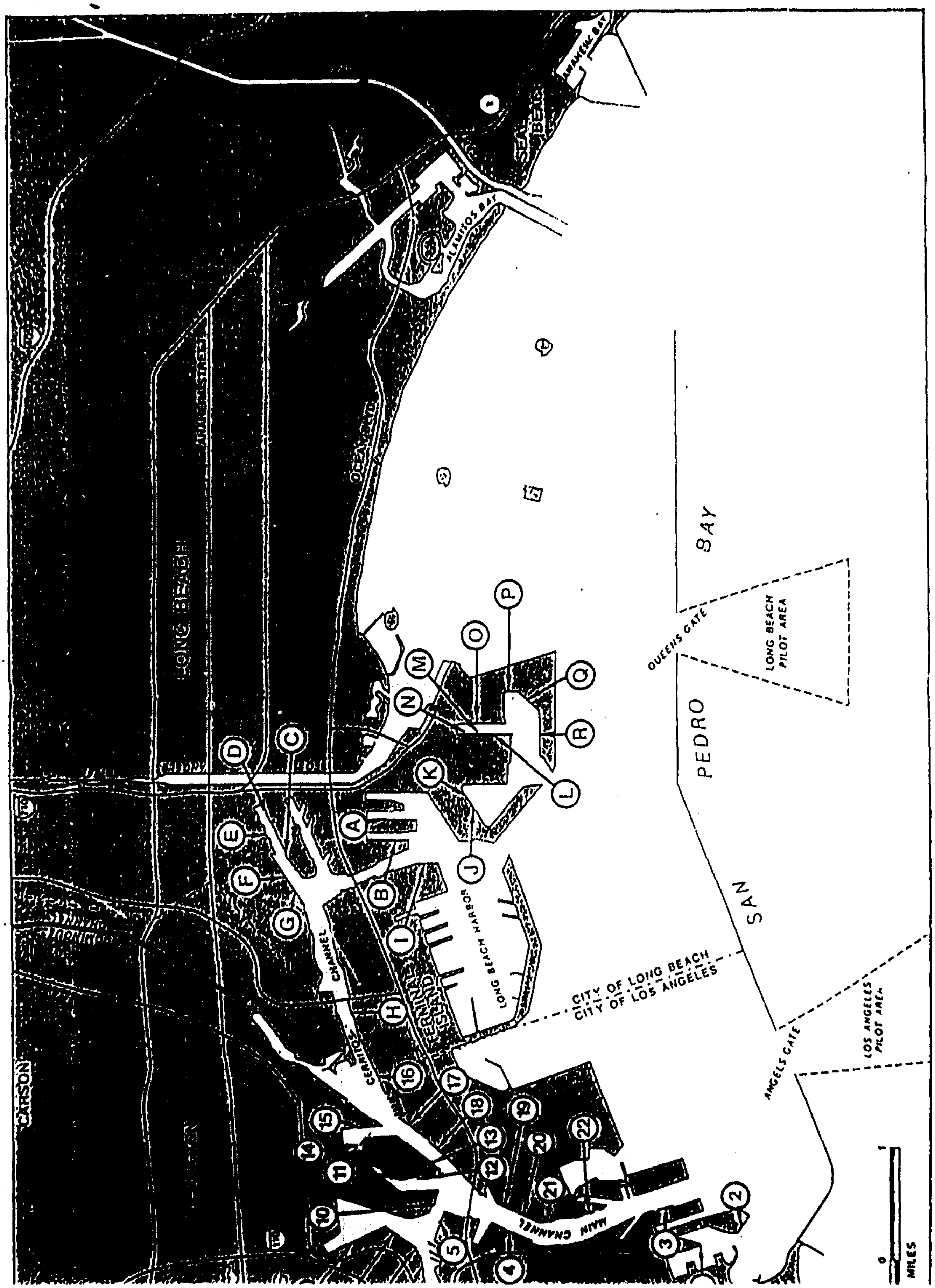

CARSON
LONG BEACH
ALAMITOS BAY
ANAHEIM BAY
CERRITOS CHANNEL
TERMINAL ISLAND
LONG BEACH HARBOR
MAIN CHANNEL
CITY OF LONG BEACH
CITY OF LOS ANGELES
QUEENS GATE
LONG BEACH PILOT AREA
ANGELS GATE
LOS ANGELES PILOT AREA
SAN PEDRO BAY
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
2
3
4
5
10
11
12
13
14
15
16
17
18
19
20
21
22
0
1
MILES

TABLE 5. Types of materials handled at LA/LB facilities. [PP = Petroleum Products, PC = Petrochemicals, C = Chemicals]

		Container	PP	PC	C
Port of Los Angeles					
1	U.S. Navy Fuel Depot		x		
2	Mobil Oil Corporation		x		
2	Union Oil Co Bulk Terminal		x		
3	GATX		x	x	x
3	Pennzoil Company		x		
4	Korea Shipping Terminal	x			
5	Chevron USA, Inc.		x		
6	GATX		x		
7	Petrolane, Inc.		x		
7	Western Fuel Oil Company		x		
7	BP North America Trading, Inc.		x		x
8	American President Lines,	x			
9	LA Container Terminal	x			
10	Los Angeles Terminals, Inc.				x
10	Union Oil Co.		x		x
11	Champlin Petroleum Company		x		
11	Chevron Chemical Co.		x		
11	Golden Eagle Refining Company, Inc.		x		
12	Shell Oil Co.		x		
13	GATX		x		
14	Los Angeles Dept. of Water and Power		x		
15	Wilmington Liquid Bulk Terminals, Inc.			x	x
16	Matson Terminals, Inc.		x		
17	BP North America Trading, Inc.			x	
18	Refiners Marketing Company			x	x
19	Overseas Shipping Co.		x		
20	Marine Terminals Corp.		x		
21	Evergreen Marine Corp.		x		
22	Mobil Oil Corp.			x	
Port of Long Beach					
A	California United Terminals		x		
B	Metropolitan Stevedore			x	
C	Procter and Gamble Manufacturing Company				x
D	Powerine Oil Co.			x	
E	Atlantic Richfield Co.			x	x
F	Long Beach Terminal Co.			x	
G	Texaco, Inc			x	
H	Dow Chemical USA				x
I	Atlantic Richfield			x	

TABLE 5. Continued.

		Container	PP	PC	C
J	Exxon Co, USA		x		
K	C. Brewer Terminals		x		
L	Sea-Land Service	x			
M	Maersk Line Agency	x			
N	United States Lines	x			
O	International Transportation Service	x			
P	C. Brewer Terminals		x	x	x
Q	Long Beach Container Ter	x			
R	Pacific Container Terminal	x			

TABLE 6. Index and statistics for facilities which handle only petroleum products.

Facility	Identification Number/Letter	Number of Storage Tanks	Total Storage Capacity (in bbls)
Atlantic Richfield Company	I	40	2,300,000
C. Brewer Terminals	K	5	66,000
BP North America Trading	17	9	300,000
Champlin Petroleum Company	11	17	960,000
Chevron Chemical Company	11	8	168,350
Chevron USA, Inc.	5	20	800,000
Exxon Company USA	J	4	398,000
GATX	6	18	517,000
GATX	13	19	1,000,000
Golden Eagle Refining Company	11	9	300,000
Long Beach Terminal Company	F	7	410,000
Los Angeles Department of Water and Power	14	5	1,080,000
Metropolitan Stevedore	B	24	(tons) 22,000
Mobil Oil Corporation	2	7	1,350,000
Mobil Oil Corporation	22	22	1,190,000
Pennzoil Company	3	9	107,600
Petrolane, Inc.	7	2	600,000
Powerine Oil Company	D	9	543,000
Shell Oil Company	12	15	525,000
Texaco, Inc.	G	106	6,109,000
Union Oil Company	2	9	2,000,000
United States Navy Fuel Depot	1	39	1,601,500

The distribution of sand beaches in the study area is also indicated in Figure 9. These beaches range from fine- to coarse-grained sand depending on their exposure to wave energy. The fine-grained sand beaches are concentrated around man-made structures (predominantly jetties) which tend to diminish wave energy. Coarse-grained sand beaches occur along Long Beach, portions of Seal Beach, and near Point Fermin. Sensitivity to spilled oil or hazardous materials would be low-to-moderate, as the relatively high-energy nature of these beaches makes them unsuitable habitats for many plant and animal species. Vegetation occurs above the high-tide swash lines, and burrowing organisms exist in the intertidal zone. Damage to these intertidal organisms from spilled oil would be limited, because they would experience short-term exposure as most spilled materials would be deposited over the berm crest. On fine-grained sand beaches, oil could penetrate to a maximum of 10-20 cm, while burial on coarse-grained sand beaches could be considerably deeper. The beaches in the study area receive extensive use for recreational purposes; therefore, the socioeconomic impact of spilled materials could exceed the damages incurred by resident organisms.

Two extensive wetland areas exist in the eastern portion of the study area (Fig. 9): the Los Cerritos wetlands and Anaheim Bay. Subenvironments in these areas include marshes and tidal flats (Table 11), both of which are sheltered from wave energy and, therefore, are highly sensitive to spilled oil or hazardous materials. These environments represent areas of concentrated biomass productivity with numerous bird, fish, and invertebrate populations. Wetlands serve as spawning, breeding, and juvenile-rearing grounds for many of these organisms. The wetlands are exposed to low-energy marine influence and generally are not self-cleansing, so long-term persistence (5-10 years) of spilled materials is common in the case of heavy accumulations.

305.3. Wildlife Distribution

Many species of aquatic birds, fish, and invertebrates reside or migrate through the San Pedro Bay study area (Table 12). The distribution of various species is closely linked to habitat types, with differing populations occurring between rocky shorelines, sand beaches, wetlands, and offshore environments. Seasonality, point localities, and species ranges are discussed below.

Birds are concentrated in wetland areas, on sand beaches, and along the offshore breakwaters which shelter the LA/LB Harbor from open marine waters (Fig. 9). Wading birds are year-round residents of wetland areas, while these areas serve as winter nesting grounds for waterfowl (California DFG, 1980). Shorebirds are present along Long Beach and Seal Beach, as well as the marsh areas of Anaheim Bay. Diving birds and seabirds are concentrated along the offshore breakwaters. Anaheim Bay serves as a nesting area for light-footed clapper rails and California least terns. Issues associated with the nesting sites for least tern which are maintained on Terminal Island by the Los Angeles Harbor Department will have to be resolved before certain planned harbor developments can take place (Kawasaki et al., 1985).

Widespread distribution of numerous invertebrate species occurs throughout the study area (Table 12). Molluscs associated with rocky environments are concentrated in the Point Fermin vicinity. Spiny lobsters are found all along the offshore breakwaters as are various types of clams, mussels, scallops, and crabs. Pismo clams, littleneck clams, and California sea mussels are found along the beaches and jetties of Long Beach and Seal Beach. Invertebrates restricted to the bay and lagoon environments of Los Cerritos and Anaheim Bay wetlands are also indicated in Table 12.

Over one hundred species of fish occur throughout the San Pedro Bay study area (California DFG, 1980). These fish are listed in Table 12 under the categories of shallow sand-bottom, shallow rocky-bottom, offshore, and pelagic fish. Shallow sand-bottom fish occur within LA/LB harbor, as well as along Long Beach and Seal Beach. Sand-bottom species restricted to the wetland environments of Anaheim Bay are also indicated in Table 12. Shallow rocky-bottom fish are concentrated in the Point Fermin vicinity and may occur along the offshore breakwaters. Offshore fish occur seaward of the breakwaters and well offshore from Long Beach and Seal Beach. Pelagic fish range throughout the entire study area but are migratory and, therefore, may be only seasonally present. About 50 percent of all the anchovies caught for live bait in southern California are netted in the outer harbors. At one time, the harbors may have provided up to 95 percent of southern California's live bait needs (USACE, 1973).

Kelp beds serve as food sources and protective areas for numerous fish and invertebrate populations. Kelp beds occur offshore from Point Fermin and the adjacent breakwater. Eelgrass occurs in close proximity to the

jetties which protect the entrance to Anaheim Bay. Marine mammals, such as gray whales and certain species of dolphins, may migrate through the off-shore waters of the study area.

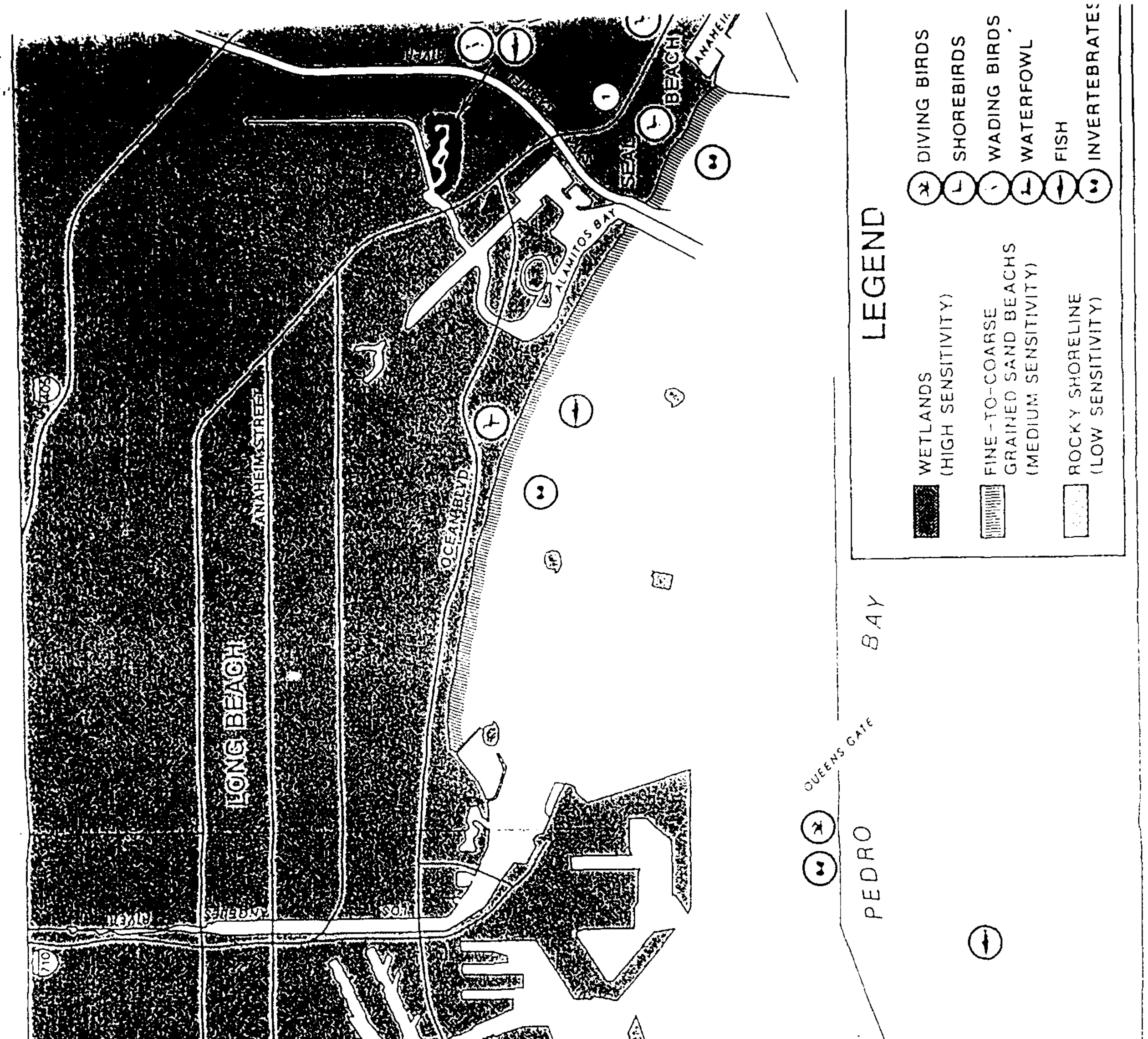
305.4. Wildlife Sensitivity

The possible impacts to birds exposed to spilled materials include oiling of their protective feathers, the ingestion of contaminated food, and roosting on contaminated beaches. Oil or hazardous materials on their feathers could be transferred to eggs. Invertebrates could suffer ingestion of toxic substances from the water column or from the infilling of their burrows. Molluscs on rocky shorelines and man-made structures would be subject to physical coating by impacting spills. Fish could ingest contaminants from the water column, and certain species that spawn in wetland or intertidal areas would expose eggs or larvae to spilled materials. Adult kelp may be protected by a mucilaginous covering on blades, but kelp in reproductive stages that do not have this covering may be more susceptible to oil or hazardous material damage (Nelson-Smith, 1972).

305.5. Conclusions

The shoreline within the study area can be classified into four broad categories with respect to vulnerability to spilled oil or hazardous materials: high-sensitivity areas, medium-sensitivity areas, low-sensitivity areas, and man-made structure areas. Low-sensitivity areas include the Point Fermin vicinity in the western portion of the study area, while medium-sensitivity areas occur along the sand beaches of Long Beach and Seal Beach. High-sensitivity areas include Los Cerritos and Anaheim Bay wetlands, while all of LA/LB Harbor and portions of Alamitos and Anaheim Bays are dominated by man-made structures.

The San Pedro Bay area provides habitat for numerous permanent and migratory wildlife species. The greatest species diversity occurs in the wetland areas, but wildlife occurs throughout the study area. All types of wildlife would be susceptible to varying degrees of damage by spilled oil or hazardous materials.


LONG BEACH
CARSON
WILMINGTON
LOS ANGELES
SAN PEDRO
TERMINAL ISLAND
SEAL BEACH
ANAHEIM
ANAHEIM STREET
OCEAN BLVD.
ALAMITOS BAY
DOMINGUEZ CHANNEL
CERRITOS CHANNEL
MAIN CHANNEL
LONG BEACH HARBOR
QUEENS GATE
ANGELS GATE
SAN PEDRO BAY
LEGEND
WETLANDS (HIGH SENSITIVITY)
FINE-TO-COARSE GRAINED SAND BEACHS (MEDIUM SENSITIVITY)
ROCKY SHORELINE (LOW SENSITIVITY)
DIVING BIRDS
SHOREBIRDS
WADING BIRDS
WATERFOWL
FISH
INVERTEBRATES
1
0.5
0
MILES

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix C Zone 3 Los Angeles/Long Beach, CA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone	301A	
4110	A	LONG BEACH HARBOR, CALIF.
4120	A	LOS ANGELES HARBOR, CALIF.
Subzone	302B	
4110	A	LONG BEACH HARBOR, CALIF.
4120	A	LOS ANGELES HARBOR, CALIF.
Subzone	303C	
4110	A	LONG BEACH HARBOR, CALIF.
4120	A	LOS ANGELES HARBOR, CALIF.
Subzone	304D	
4110	A	LONG BEACH HARBOR, CALIF.
4120	A	LOS ANGELES HARBOR, CALIF.

Appendix C Zone 3 Los Angeles/Long Beach, CA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 301A Pacific Off Los Angeles

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,419,385	0	0	0	2,419,385
2	FOREST PRODUCTS	79,451	0	0	0	79,451
3	FISHERIES PRODUCTS	163,173	0	0	0	163,173
4	MINING PRODUCTS, NEC	2,904,163	0	14	0	2,904,177
5	PROC. FOODS & MFTRS, NEC	28,265,396	0	134,403	0	28,399,799
6	WASTE OF MANUFACTURING	2,971,698	0	349	0	2,972,047
1311	CRUDE PETROLEUM	0	24,575,838	0	203,069	24,778,907
1492	SULPHUR, DRY	522,952	0	0	0	522,952
2810	SODIUM HYDROXIDE (CAUSTI	41,244	0	0	0	41,244
2811	CRUDE PROD-COAL TAR-PET	17,331	0	0	0	17,331
2813	ALCOHOLS	0	79,134	0	5,985	85,119
2817	BENZENE AND TOLUENE	0	112,940	0	19,643	132,583
2871	NITROGEN CHEM FERTILIZER	16,608	6,125	0	29	22,762
2872	POTASSIC CHEM FERTILIZER	34,429	0	0	0	34,429
2873	PHOSPHA CHEM FERTILIZERS	1,445	0	0	0	1,445
2911	GASOLINE, INCL NATURAL	0	2,651,837	0	59,096	2,710,933
2912	JET FUEL	0	887,459	0	195	887,654
2913	KEROSENE	0	25	0	0	25
2914	DISTILLATE FUEL OIL	0	2,453,140	0	480,787	2,933,927
2915	RESIDUAL FUEL OIL	0	4,422,011	0	11,717,126	16,139,137
2916	LUBRIC OILS-GREASES	0	768,296	0	10,248	778,544
2917	NAPHTHA, PETRLM SOLVENTS	0	139,850	0	1	139,851
2921	LIQUI PETR-COAL-NATR GAS	123	78,421	0	2	78,546
	Subzone Total :	37,437,398	36,175,076	134,766	12,496,181	86,243,421

Subzone 302B Outside the Breakwater

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,419,385	0	0	0	2,419,385
2	FORCST PRODUCTS	79,451	0	0	0	79,451
3	FISHERIES PRODUCTS	163,173	0	0	0	163,173
4	MIN'NG PRODUCTS, NEC	2,904,163	0	14	0	2,904,177
5	PROC. FOODS & MFTRS, NEC	28,265,396	0	134,403	0	28,399,799
6	WASTE OF MANUFACTURING	2,971,698	0	349	0	2,972,047
1311	CRUDE PETROLEUM	0	24,575,838	0	203,069	24,778,907
1492	SULPHUR, DRY	522,952	0	0	0	522,952
2810	SODIUM HYDROXIDE (CAUSTI	41,244	0	0	0	41,244
2811	CRUDE PROD-COAL TAR-PET	17,331	0	0	0	17,331
2813	ALCOHOLS	0	79,134	0	5,985	85,119
2817	BENZENE AND TOLUENE	0	112,940	0	19,643	132,583
2871	NITROGEN CHEM FERTILIZER	16,608	6,125	0	29	22,762
2872	POTASSIC CHEM FERTILIZER	34,429	0	0	0	34,429
2873	PHOSPHA CHEM FERTILIZERS	1,445	0	0	0	1,445
2911	GASOLINE, INCL NATURAL	0	2,651,837	0	59,096	2,710,933
2912	JET FUEL	0	887,459	0	195	887,654
2913	KEROSENE	0	25	0	0	25
2914	DISTILLATE FUEL OIL	0	2,453,140	0	480,787	2,933,927
2915	RESIDUAL FUEL OIL	0	4,422,011	0	11,717,126	16,139,137
2916	LUBRIC OILS-GREASES	0	768,296	0	10,248	778,544
2917	NAPHTHA, PETRLM SOLVENTS	0	139,850	0	1	139,851
2921	LIQUI PETR-COAL-NATR GAS	123	78,421	0	2	78,546
	Subzone Total :	37,437,398	36,175,076	134,766	12,496,181	86,243,421

Appendix C Zone 3 Los Angeles/Long Beach, CA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 303C Inside the breakwater

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,419,385	0	0	0	2,419,385
2	FOREST PRODUCTS	79,451	0	0	0	79,451
3	FISHERIES PRODUCTS	163,173	0	0	0	163,173
4	MINING PRODUCTS, NEC	2,904,163	0	14	0	2,904,177
5	PROC. FOODS & MFTRS, NEC	28,265,396	0	134,403	0	28,399,799
6	WASTE OF MANUFACTURING	2,971,698	0	349	0	2,972,047
1311	CRUDE PETROLEUM	0	24,575,838	0	203,069	24,778,907
1492	SULPHUR, DRY	522,952	0	0	0	522,952
2810	SODIUM HYDROXIDE (CAUSTI	41,244	0	0	0	41,244
2811	CRUDE PROD-COAL TAR-PET	17,331	0	0	0	17,331
2813	ALCOHOLS	0	79,134	0	5,985	85,119
2817	BENZENE AND TOLUENE	0	112,940	0	19,643	132,583
2871	NITROGEN CHEM FERTILIZER	16,608	6,125	0	29	22,762
2872	POTASSIC CHEM FERTILIZER	34,429	0	0	0	34,429
2873	PHOSPHA CHEM FERTILIZERS	1,445	0	0	0	1,445
2911	GASOLINE, INCL NATURAL	0	2,651,837	0	59,096	2,710,933
2912	JET FUEL	0	887,459	0	195	887,654
2913	KEROSENE	0	25	0	0	25
2914	DISTILLATE FUEL OIL	0	2,453,140	0	480,787	2,933,927
2915	RESIDUAL FUEL OIL	0	4,422,011	0	11,717,126	16,139,137
2916	LUBRIC OILS-GREASES	0	768,296	0	10,248	778,544
2917	NAPHTHA, PETRLM SOLVENTS	0	139,850	0	1	139,851
2921	LIQUI PETR-COAL-NATR GAS	123	78,421	0	2	78,546
	Subzone Total :	37,437,398	36,175,076	134,766	12,496,181	86,243,421

Subzone 304D Port Facilities area

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,419,385	0	0	0	2,419,385
2	FOREST PRODUCTS	79,451	0	0	0	79,451
3	FISHERIES PRODUCTS	163,173	0	0	0	163,173
4	MINING PRODUCTS, NEC	2,904,163	0	14	0	2,904,177
5	PROC. FOODS & MFTRS, NEC	28,265,396	0	134,403	0	28,399,799
6	WASTE OF MANUFACTURING	2,971,698	0	349	0	2,972,047
1311	CRUDE PETROLEUM	0	24,575,838	0	203,069	24,778,907
1492	SULPHUR, DRY	522,952	0	0	0	522,952
2810	SODIUM HYDROXIDE (CAUSTI	41,244	0	0	0	41,244
2811	CRUDE PROD-COAL TAR-PET	17,331	0	0	0	17,331
2813	ALCOHOLS	0	79,134	0	5,985	85,119
2817	BENZENE AND TOLUENE	0	112,940	0	19,643	132,583
2871	NITROGEN CHEM FERTILIZER	16,608	6,125	0	29	22,762
2872	POTASSIC CHEM FERTILIZER	34,429	0	0	0	34,429
2873	PHOSPHA CHEM FERTILIZERS	1,445	0	0	0	1,445
2911	GASOLINE, INCL NATURAL	0	2,651,837	0	59,096	2,710,933
2912	JET FUEL	0	887,459	0	195	887,654
2913	KEROSENE	0	25	0	0	25
2914	DISTILLATE FUEL OIL	0	2,453,140	0	480,787	2,933,927
2915	RESIDUAL FUEL OIL	0	4,422,011	0	11,717,126	16,139,137
2916	LUBRIC OILS-GREASES	0	768,296	0	10,248	778,544
2917	NAPHTHA, PETRLM SOLVENTS	0	139,850	0	1	139,851
2921	LIQUI PETR-COAL-NATR GAS	123	78,421	0	2	78,546
	Subzone Total :	37,437,398	36,175,076	134,766	12,496,181	86,243,421

Appendix C ZONE 3 Los Angeles/Long Beach, CA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 301A				
Passenger	0	770	14,950	15,720
Dry Cargo	3,901	4,318	56,946	67,165
Tanker	1,318	772	1,421	3,511
Dry Cargo Barge Tow	11	0	1,067	1,078
Tanker Barge Tow	130	0	16,118	16,248
Tug/Tow Boat	0	0	37,895	37,895
Subzone Total:	5,360	5,860	130,397	141,617
Subzone : 302B				
Passenger	0	770	14,950	15,720
Dry Cargo	3,901	4,318	58,946	67,165
Tanker	1,318	772	1,421	3,511
Dry Cargo Barge Tow	11	0	1,067	1,078
Tanker Barge Tow	130	0	16,118	16,248
Tug/Tow Boat	0	0	37,895	37,895
Subzone Total:	5,360	5,860	130,397	141,617
Subzone : 303C				
Passenger	0	770	17,503	18,273
Dry Cargo	3,901	4,318	58,946	67,165
Tanker	1,318	772	1,421	3,511
Dry Cargo Barge Tow	11	0	1,067	1,078
Tanker Barge Tow	130	0	16,118	16,248
Tug/Tow Boat	0	0	37,895	37,895
Subzone Total:	5,360	5,860	132,950	144,170
Subzone : 304D				
Passenger	0	770	17,503	18,273
Dry Cargo	3,901	4,318	58,946	67,165
Tanker	1,318	772	1,421	3,511
Dry Cargo Barge Tow	11	0	1,067	1,078
Tanker Barge Tow	130	0	16,118	16,248
Tug/Tow Boat	0	0	37,895	37,895
Subzone Total:	5,360	5,860	132,950	144,170

Note: Sum of all vessel transits within each study subzone.

7/22/91

Appendix C ZONE 3 Los Angeles/Long Beach, CA

TABLE 3 **Base Year** (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 3 Los Angeles/Long Beach, CA

Vessel Type	Large	Medium	Small	Total
Passenger	0	770	17,503	18,273
Dry Cargo	3,901	4,318	58,946	67,165
Tanker	1,318	772	1,421	3,511
Dry Cargo Barge Tow	11	0	1,067	1,078
Tanker Barge Tow	130	0	16,118	16,248
Tug/Tow Boat	0	0	37,895	37,895
Zone Total:	5,360	5,860	132,950	144,170

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix C Zone 3 Los Angeles/Long Beach, CA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix C Zone 3 Los Angeles/Long Beach, CA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
301A	Pacific Off Los Angeles	51,648	113.02
302B	Outside the Breakwater	51,648	993.23
303C	Inside the breakwater	51,648	28,693.33
304D	Port Facilities area	29,847	6,091.22
	Total for Zone	184,791	358.33

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix C ZONE 3 Los Angeles/Long Beach, CA 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 301A				
Passenger	0	811	15,833	16,644
Dry Cargo	5,044	5,819	77,173	88,036
Tanker	1,425	833	1,515	3,773
Dry Cargo Tow	0	0	1,179	1,179
Tanker Tow	15	0	18,025	18,040
Tug/Tow Boat	0	0	48,299	48,299
Subzone Total:	6,484	7,463	162,024	175,971
Subzone : 302B				
Passenger	0	811	15,833	16,644
Dry Cargo	5,044	5,819	77,173	88,036
Tanker	1,425	833	1,515	3,773
Dry Cargo Tow	0	0	1,179	1,179
Tanker Tow	15	0	18,025	18,040
Tug/Tow Boat	0	0	48,299	48,299
Subzone Total:	6,484	7,463	162,024	175,971
Subzone : 303C				
Passenger	0	811	18,522	19,333
Dry Cargo	5,044	5,819	77,173	88,036
Tanker	1,425	833	1,515	3,773
Dry Cargo Tow	0	0	1,179	1,179
Tanker Tow	15	0	18,025	18,040
Tug/Tow Boat	0	0	48,299	48,299
Subzone Total:	6,484	7,463	164,713	178,660
Subzone : 304D				
Passenger	0	811	18,522	19,333
Dry Cargo	5,044	5,819	77,173	88,036
Tanker	1,425	833	1,515	3,773
Dry Cargo Tow	0	0	1,179	1,179
Tanker Tow	15	0	18,025	18,040
Tug/Tow Boat	0	0	48,299	48,299
Subzone Total:	6,484	7,463	164,713	178,660

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix C ZONE 3 Los Angeles/Long Beach, CA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 301A				
Passenger	0	854	16,674	17,528
Dry Cargo	6,039	6,869	91,006	103,914
Tanker	1,509	905	1,621	4,035
Dry Cargo Tow	0	0	1,257	1,257
Tanker Tow	16	0	19,333	19,349
Tug/Tow Boat	0	0	56,477	56,477
Subzone Total:	7,564	8,628	186,368	202,560
Subzone : 302B				
Passenger	0	854	16,674	17,528
Dry Cargo	6,039	6,869	91,006	103,914
Tanker	1,509	905	1,621	4,035
Dry Cargo Tow	0	0	1,257	1,257
Tanker Tow	16	0	19,333	19,349
Tug/Tow Boat	0	0	56,477	56,477
Subzone Total:	7,564	8,628	186,368	202,560
Subzone : 303C				
Passenger	0	854	19,505	20,359
Dry Cargo	6,039	6,869	91,006	103,914
Tanker	1,509	905	1,621	4,035
Dry Cargo Tow	0	0	1,257	1,257
Tanker Tow	16	0	19,333	19,349
Tug/Tow Boat	0	0	56,477	56,477
Subzone Total:	7,564	8,628	189,199	205,391
Subzone : 304D				
Passenger	0	854	19,505	20,359
Dry Cargo	6,039	6,869	91,006	103,914
Tanker	1,509	905	1,621	4,035
Dry Cargo Tow	0	0	1,257	1,257
Tanker Tow	16	0	19,333	19,349
Tug/Tow Boat	0	0	56,477	56,477
Subzone Total:	7,564	8,628	189,199	205,391

Note: Sum of all vessel transits within each study subzone.

Appendix C ZONE 3 Los Angeles/Long Beach, CA 7/24/91

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 301A				
Passenger	0	884	17,257	18,141
Dry Cargo	7,305	8,175	107,992	123,472
Tanker	1,598	984	1,738	4,320
Dry Cargo Tow	0	0	1,342	1,342
Tanker Tow	17	0	20,737	20,754
Tug/Tow Boat	0	0	66,663	66,663
Subzone Total:	8,920	10,043	215,729	234,692
Subzone : 302B				
Passenger	0	884	17,257	18,141
Dry Cargo	7,305	8,175	107,992	123,472
Tanker	1,598	984	1,738	4,320
Dry Cargo Tow	0	0	1,342	1,342
Tanker Tow	17	0	20,737	20,754
Tug/Tow Boat	0	0	66,663	66,663
Subzone Total:	8,920	10,043	215,729	234,692
Subzone : 303C				
Passenger	0	884	20,187	21,071
Dry Cargo	7,305	8,175	107,992	123,472
Tanker	1,598	984	1,738	4,320
Dry Cargo Tow	0	0	1,342	1,342
Tanker Tow	17	0	20,737	20,754
Tug/Tow Boat	0	0	66,663	66,663
Subzone Total:	8,920	10,043	218,659	237,622
Subzone : 304D				
Passenger	0	884	20,187	21,071
Dry Cargo	7,305	8,175	107,992	123,472
Tanker	1,598	984	1,738	4,320
Dry Cargo Tow	0	0	1,342	1,342
Tanker Tow	17	0	20,737	20,754
Tug/Tow Boat	0	0	66,663	66,663
Subzone Total:	8,920	10,043	218,659	237,622

Note: Sum of all vessel transits within each study subzone.

Appendix C ZONE 3 Los Angeles/Long Beach, CA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 301A				
Passenger	0	915	17,861	18,775
Dry Cargo	8,928	9,833	129,046	147,807
Tanker	1,685	1,072	1,861	4,618
Dry Cargo Tow	0	0	1,434	1,434
Tanker Tow	19	0	22,246	22,265
Tug/Tow Boat	0	0	79,535	79,535
Subzone Total:	10,632	11,820	251,983	274,434
Subzone : 302B				
Passenger	0	915	17,861	18,775
Dry Cargo	8,928	9,833	129,046	147,807
Tanker	1,685	1,072	1,861	4,618
Dry Cargo Tow	0	0	1,434	1,434
Tanker Tow	19	0	22,246	22,265
Tug/Tow Boat	0	0	79,535	79,535
Subzone Total:	10,632	11,820	251,983	274,434
Subzone : 303C				
Passenger	0	915	20,894	21,808
Dry Cargo	8,928	9,833	129,046	147,807
Tanker	1,685	1,072	1,861	4,618
Dry Cargo Tow	0	0	1,434	1,434
Tanker Tow	19	0	22,246	22,265
Tug/Tow Boat	0	0	79,535	79,535
Subzone Total:	10,632	11,820	255,016	277,467
Subzone : 304D				
Passenger	0	915	20,894	21,808
Dry Cargo	8,928	9,833	129,046	147,807
Tanker	1,685	1,072	1,861	4,618
Dry Cargo Tow	0	0	1,434	1,434
Tanker Tow	19	0	22,246	22,265
Tug/Tow Boat	0	0	79,535	79,535
Subzone Total:	10,632	11,820	255,016	277,467

Note: Sum of all vessel transits within each study subzone.

Appendix C ZONE 3 Los Angeles/Long Beach, CA 7/25/91

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	811	18,432	19,243
Dry Cargo	4,537	5,236	69,370	79,143
Tanker	1,425	833	1,515	3,773
Dry Cargo Tow	0	0	1,179	1,179
Tanker Tow	15	0	18,025	18,040
Tug/Tow Boat	0	0	48,299	48,299
1995 Zone Total:	5,977	6,880	156,820	169,677
2000 FORECASTED ZONE TOTALS				
Passenger	0	854	19,411	20,265
Dry Cargo	5,086	5,789	76,550	87,425
Tanker	1,509	905	1,621	4,035
Dry Cargo Tow	0	0	1,257	1,257
Tanker Tow	16	0	19,333	19,349
Tug/Tow Boat	0	0	56,477	56,477
2000 Zone Total:	6,611	7,548	174,649	188,808
2005 FORECASTED ZONE TOTALS				
Passenger	0	884	20,090	20,974
Dry Cargo	6,153	6,656	87,709	100,518
Tanker	1,598	984	1,738	4,320
Dry Cargo Tow	0	0	1,342	1,342
Tanker Tow	17	0	20,737	20,754
Tug/Tow Boat	0	0	66,663	66,663
2005 Zone Total:	7,768	8,524	198,279	214,571
2010 FORECASTED ZONE TOTALS				
Passenger	0	915	20,793	21,707
Dry Cargo	7,522	8,005	104,804	120,331
Tanker	1,685	1,072	1,861	4,618
Dry Cargo Tow	0	0	1,434	1,434
Tanker Tow	19	0	22,246	22,265
Tug/Tow Boat	0	0	79,535	79,535
2010 Zone Total:	9,226	9,992	230,673	249,890

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix C Zone 3 Los Angeles/Long Beach, CA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 301A Pacific Off Los Angeles						
Passenger	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 302B Outside the Breakwater						
Dry Cargo	Large	1	2	0	0	3
Tanker	Large	2	0	0	0	2
Dry Cargo Barge Tow	Small	1	0	0	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		6	2	0	0	8
Subzone: 303C Inside the breakwater						
Dry Cargo	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 304D Port Facilities area						
Passenger	Small	1	1	0	0	2
Dry Cargo	Large	0	0	1	0	1
Tanker	Large	0	1	0	0	1
Dry Cargo Barge Tow	Small	0	1	0	0	1
Tanker Barge Tow	Small	1	1	0	0	2
Subzone Totals:		2	4	1	0	7
Zone Totals:		8	6	3	0	17

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE C-8 ZONE 3, LA/LONG BEACH, CA - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0301A																	III
0302B	II	II	II	II	II	II	II	II	II	II	II	II					III
0303C	II	II	II	II	II	II	II	II	II	II	II	II					III
0304D	II	II	II	II	II	II	II	II	II	II	II	II					III

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

NOTE ALL VESSELS WITH DRAFT GREATER THAN 18 FEET PARTICIPATE 1979 THROUGH PRESENT.

APPENDIX TABLE C-9 ZONE 3, LOS ANGELES/LONG BEACH, CA - CANDIDATE VTS DESIGN - 1995-2010

UNITS		
2	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
2	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
5	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
1	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
2	Meteorological Module 12	- Air temperature, wind direction and speed
2	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
1	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix C Zone 3 Los Angeles/Long Beach, CA

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.69	0.00	.88	1.57
Passenger	Small	.35	.06	.40	.81
Dry Cargo	Large	2.12	.38	3.08	5.58
Dry Cargo	Medium	.94	.16	.44	1.53
Dry Cargo	Small	4.18	.50	.86	5.54
Tanker	Large	1.13	.28	1.83	3.23
Tanker	Medium	.09	.01	.06	.16
Tanker	Small	.07	0.00	.06	.13
Dry Cargo Barge T	Small	.33	.11	.16	.59
Tanker Barge Tow	Large	.00	.00	.00	.01
Tanker Barge Tow	Small	5.50	1.02	4.35	10.87
Tug/Tow Boat	Small	1.28	.49	1.31	3.09
		16.67	2.99	13.44	33.10

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	1,825	0	1,278	3,103
Passenger	Small	355	48	278	681
Dry Cargo	Large	4,920	1,119	1,246	7,285
Dry Cargo	Medium	2,278	485	170	2,933
Dry Cargo	Small	3,433	363	622	4,418
Tanker	Large	18,751	4,599	19,029	42,379
Tanker	Medium	251	26	57	333
Tanker	Small	90	0	26	116
Dry Cargo Barge T	Small	18	4	3	24
Tanker Barge Tow	Large	74	36	39	149
Tanker Barge Tow	Small	52,031	9,592	6,994	68,617
Tug/Tow Boat	Small	131	35	129	295
		84,156	16,306	29,871	130,333

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix C Zone 3 Los Angeles/Long Beach, CA

TABLE 10B Avoided Vessel Casualties 1996 - 2010 7/31/91
Existing VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.53	0.00	.77	1.31
Passenger	Small	.27	.05	.35	.67
Dry Cargo	Large	1.65	.35	2.70	4.70
Dry Cargo	Medium	.73	.15	.38	1.26
Dry Cargo	Small	3.25	.47	.75	4.47
Tanker	Large	.88	.26	1.60	2.74
Tanker	Medium	.07	.01	.05	.13
Tanker	Small	.05	0.00	.05	.10
Dry Cargo Barge T	Small	.26	.10	.14	.49
Tanker Barge Tow	Large	.00	.00	.00	.01
Tanker Barge Tow	Small	4.28	.96	3.80	9.04
Tug/Tow Boat	Small	.99	.47	1.15	2.60
		12.95	2.82	11.76	27.52

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	1,418	0	1,121	2,539
Passenger	Small	272	44	238	554
Dry Cargo	Large	3,822	1,045	1,093	5,959
Dry Cargo	Medium	1,770	453	149	2,372
Dry Cargo	Small	2,670	342	544	3,556
Tanker	Large	14,568	4,296	16,694	35,559
Tanker	Medium	195	24	50	269
Tanker	Small	70	0	23	93
Dry Cargo Barge T	Small	14	3	2	19
Tanker Barge Tow	Large	57	34	34	126
Tanker Barge Tow	Small	40,486	9,042	6,119	55,647
Tug/Tow Boat	Small	101	33	112	247
		65,443	15,317	26,179	106,939

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.09	0.00	.11	.20
Passenger	Small	.02	.00	.03	.05
Dry Cargo	Large	.27	.05	.39	.70
Dry Cargo	Medium	.12	.02	.05	.19
Dry Cargo	Small	.27	.03	.05	.35
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.77	.11	.65	1.53
Candidate VTS Design - Dollars					
Passenger	Medium	128,972.24	0.00	165,880.13	294,852.37
Passenger	Small	33,824.22	5,334.62	38,779.34	77,938.17
Dry Cargo	Large	398,788.75	71,293.65	580,326.51	1,050,408.91
Dry Cargo	Medium	176,018.79	29,806.90	82,316.63	288,142.31
Dry Cargo	Small	401,047.23	48,305.88	82,352.19	531,705.30
Tanker	Small	218.63	0.00	201.52	420.16
Dry Cargo Barge Tow	Small	1,093.21	350.59	514.61	1,958.40
Tanker Barge Tow	Small	18,185.61	3,365.83	14,381.55	35,932.99
Tug/Tow Boat	Small	4,236.25	1,616.48	4,346.32	10,199.05
Totals		1,162,384.92	160,073.94	969,098.80	2,291,557.65
Existing VTS Design - Counts					
Passenger	Medium	.07	0.00	.10	.16
Passenger	Small	.02	.00	.02	.04
Dry Cargo	Large	.21	.04	.34	.59
Dry Cargo	Medium	.09	.02	.05	.16
Dry Cargo	Small	.21	.03	.05	.29
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.60	.10	.57	1.27
Existing VTS Design - Dollars					
Passenger	Medium	100,175.96	0.00	145,429.53	245,605.49
Passenger	Small	25,914.76	4,938.20	33,228.49	64,081.45
Dry Cargo	Large	309,749.20	66,560.08	508,780.71	885,089.99
Dry Cargo	Medium	136,718.19	27,827.86	72,168.19	236,714.24
Dry Cargo	Small	311,958.89	45,546.85	72,016.18	429,521.92
Tanker	Small	170.07	0.00	176.23	346.30
Dry Cargo Barge Tow	Small	850.36	330.56	450.02	1,630.95
Tanker Barge Tow	Small	14,145.87	3,173.59	12,576.52	29,895.98
Tug/Tow Boat	Small	3,267.25	1,542.81	3,788.47	8,598.53
Totals		902,950.57	149,919.94	848,614.34	1,901,484.84

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Candidate VTS Design - Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.27	.04	.31	.62
Dry Cargo	Large	.03	.01	.04	.08
Dry Cargo	Medium	.01	.00	.01	.02
Dry Cargo	Small	3.17	.38	.65	4.20
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.13	.02	.11	.26
Tug/Tow Boat	Small	.03	.01	.03	.07
Totals		3.66	.47	1.16	5.29

Candidate VTS Design - Dollars

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	2,214.42	0.00	2,848.12	5,062.54
Passenger	Small	63,691.56	10,045.17	73,022.14	146,758.87
Dry Cargo	Large	6,847.10	1,224.09	9,964.06	18,035.25
Dry Cargo	Medium	3,022.20	511.78	1,413.36	4,947.33
Dry Cargo	Small	755,178.58	90,960.78	155,070.54	1,001,209.90
Tanker	Small	382.02	0.00	352.12	734.14
Dry Cargo Barge Tow	Small	1,910.18	612.58	899.19	3,421.95
Tanker Barge Tow	Small	31,775.97	5,881.16	25,129.08	62,786.21
Tug/Tow Boat	Small	7,402.06	2,824.50	7,594.39	17,820.95
Totals		872,424.09	112,060.06	276,292.99	1,260,777.14

Existing VTS Design - Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.20	.04	.26	.51
Dry Cargo	Large	.02	.00	.04	.06
Dry Cargo	Medium	.01	.00	.01	.02
Dry Cargo	Small	2.47	.36	.57	3.40
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.10	.02	.09	.22
Tug/Tow Boat	Small	.02	.01	.03	.06
Totals		2.85	.44	1.01	4.30

Existing VTS Design - Dollars

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	1,720.00	0.00	2,496.99	4,216.98
Passenger	Small	48,797.93	9,298.71	62,569.80	120,666.43
Dry Cargo	Large	5,318.31	1,142.82	8,735.63	15,196.76
Dry Cargo	Medium	2,347.42	477.80	1,239.11	4,064.32
Dry Cargo	Small	587,423.77	85,765.47	135,607.67	808,796.91
Tanker	Small	297.16	0.00	307.93	605.09
Dry Cargo Barge Tow	Small	1,485.85	577.60	786.33	2,849.78
Tanker Barge Tow	Small	24,717.28	5,545.25	21,975.14	52,237.67
Tug/Tow Boat	Small	5,708.92	2,695.77	6,619.65	15,024.34
Totals		677,816.63	105,503.41	240,338.24	1,023,658.28

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.51	0.00	.38	.89
Passenger	Small	.30	.04	.13	.46
Dry Cargo	Large	1.57	.27	.30	2.14
Dry Cargo	Medium	.69	.11	.04	.85
Dry Cargo	Small	3.58	.35	.45	4.38
Tanker	Large	.85	.22	.24	1.31
Tanker	Medium	.06	.01	.01	.08
Tanker	Small	.01	0.00	.01	.03
Dry Cargo Barge Tow	Small	.25	.04	.02	.32
Tanker Barge Tow	Large	.00	.00	.00	.00
Tanker Barge Tow	Small	4.20	.43	.61	5.23
Tug/Tow Boat	Small	.23	.06	.16	.44
Totals		12.27	1.53	2.35	16.15
Candidate VTS Design - Dollars					
Passenger	Medium	443,697.16	0.00	331,354.02	775,051.18
Passenger	Small	102,331.13	12,614.66	65,007.40	179,953.19
Dry Cargo	Large	1,159,102.68	198,308.00	178,711.16	1,536,121.84
Dry Cargo	Medium	618,077.10	100,163.81	18,952.42	737,193.33
Dry Cargo	Small	679,450.94	66,546.46	115,333.30	861,330.70
Tanker	Large	669,356.66	173,038.36	516,632.24	1,359,027.26
Tanker	Medium	42,857.10	4,492.07	14,529.21	61,878.38
Tanker	Small	4,332.95	0.00	5,209.33	9,542.28
Dry Cargo Barge Tow	Small	14,651.72	2,601.80	1,101.22	18,354.74
Tanker Barge Tow	Large	529.83	143.69	109.74	783.26
Tanker Barge Tow	Small	297,771 85	30,516.87	54,674.67	382,963.39
Tug/Tow Boat	Small	16,163.61	3,961.49	16,125.58	36,250.68
Totals		4,048,322.74	592,387.20	1,317,740.30	5,958,450.24
Existing VTS Design - Counts					
Passenger	Medium	.40	0.00	.33	.73
Passenger	Small	.23	.03	.11	.37
Dry Cargo	Large	1.22	.25	.26	1.74
Dry Cargo	Medium	.54	.10	.04	.68
Dry Cargo	Small	2.78	.33	.39	3.51
Tanker	Large	.66	.21	.21	1.08
Tanker	Medium	.05	.01	.01	.06
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	.20	.04	.02	.26
Tanker Barge Tow	Large	.00	.00	.00	.00
Tanker Barge Tow	Small	3.27	.41	.53	4.20
Tug/Tow Boat	Small	.17	.05	.14	.37
Totals		9.54	1.43	2.05	13.02
Existing VTS Design - Dollars					
Passenger	Medium	344,630.68	0.00	290,502.90	635,133.58
Passenger	Small	78,402.02	11,677.26	55,702.28	145,781.56
Dry Cargo	Large	900,304.05	185,141.28	156,678.68	1,242,124.00
Dry Cargo	Medium	480,075.94	93,513.40	16,615.86	590,205.21
Dry Cargo	Small	528,518.21	62,745.60	100,857.84	692,121.65
Tanker	Large	519,906.06	161,549.42	452,939.01	1,134,394.50
Tanker	Medium	33,288.18	4,193.82	12,737.97	50,219.97
Tanker	Small	3,370.43	0.00	4,555.51	7,925.94
Dry Cargo Barge Tow	Small	11,397.00	2,453.19	963.01	14,813.20
Tanker Barge Tow	Large	411.54	134.15	96.21	641.89
Tanker Barge Tow	Small	231,625.03	28,773.87	47,812.47	308,211.37
Tug/Tow Boat	Small	12,466.37	3,780.94	14,055.86	30,303.16
Totals		3,144,395.51	553,962.92	1,153,517.60	4,851,876.02

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.13	0.00	.07	.20
Passenger	Small	.07	.01	.04	.12
Dry Cargo	Large	.57	.13	.28	.98
Dry Cargo	Medium	.25	.05	.04	.34
Dry Cargo	Small	1.33	.14	.17	1.64
Tanker	Large	.30	.08	.18	.56
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Small	.05	.01	.01	.07
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.77	.14	.25	1.17
Tug/Tow Boat	Small	.09	.03	.05	.16
Totals		3.60	.60	1.09	5.30
Candidate VTS Design - Dollars					
Passenger	Medium	1,951.94	0.00	1,031.30	2,983.25
Passenger	Small	258.79	31.90	146.81	437.50
Dry Cargo	Large	5,967.68	1,511.52	821.22	8,300.42
Dry Cargo	Medium	2,634.03	631.95	116.49	3,382.47
Dry Cargo	Small	3,083.53	302.01	517.72	3,903.26
Tanker	Large	19,161.26	4,722.33	25,326.33	49,209.92
Tanker	Medium	316.23	32.73	70.42	419.38
Tanker	Small	53.66	0.00	31.03	84.69
Tanker Tow	Large	96.23	47.45	70.63	214.31
Tanker Tow	Small	62,194.35	11,511.06	20,033.62	93,739.04
Tug/Tow Boat	Small	194.57	47.68	188.95	431.20
Totals		95,912.27	18,838.62	48,354.52	163,105.42
Existing VTS Design - Counts					
Passenger	Medium	.10	0.00	.06	.16
Passenger	Small	.06	.01	.03	.10
Dry Cargo	Large	.44	.12	.25	.81
Dry Cargo	Medium	.19	.05	.03	.28
Dry Cargo	Small	1.03	.14	.15	1.32
Tanker	Large	.24	.07	.16	.46
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Small	.04	.01	.01	.06
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.60	.14	.22	.96
Tug/Tow Boat	Small	.07	.03	.04	.13
Totals		2.80	.57	.96	4.32
Existing VTS Design - Dollars					
Passenger	Medium	1,516.12	0.00	904.16	2,420.28
Passenger	Small	198.27	29.53	125.80	353.60
Dry Cargo	Large	4,635.24	1,411.16	719.98	6,766.38
Dry Cargo	Medium	2,045.92	589.99	102.13	2,738.03
Dry Cargo	Small	2,398.56	284.76	452.74	3,136.06
Tanker	Large	16,391.79	4,851.29	24,838.35	46,081.43
Tanker	Medium	251.31	31.23	66.14	348.68
Tanker	Small	44.96	0.00	28.49	73.45
Tanker Tow	Large	82.48	48.88	68.32	199.69
Tanker Tow	Small	53,543.26	12,012.28	19,386.11	84,941.66
Tug/Tow Boat	Small	150.06	45.51	164.69	360.27
Totals		81,257.98	19,304.64	46,856.91	147,419.53

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.04	.02	.06
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.06	.00	.06
Tanker	Large	0.00	.03	.01	.04
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.01	.00	.01
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.12	.02	.14
Tug/Tow Boat	Small	0.00	.06	.01	.06
Totals		0.00	.34	.07	.41
Candidate VTS Design - Dollars					
Passenger	Small	0.00	35.86	13.05	48.92
Dry Cargo	Large	0.00	244.66	99.70	344.36
Dry Cargo	Medium	0.00	102.29	14.14	116.43
Dry Cargo	Small	0.00	324.76	27.72	352.48
Tanker	Large	0.00	177.64	59.13	236.77
Tanker	Medium	0.00	5.48	1.99	7.47
Tanker	Small	0.00	0.00	1.97	1.97
Dry Cargo Barge Tow	Small	0.00	68.46	5.03	73.50
Tanker Barge Tow	Large	0.00	1.14	.09	1.23
Tanker Barge Tow	Small	0.00	657.30	140.60	797.89
Tug/Tow Boat	Small	0.00	315.68	42.49	358.17
Totals		0.00	1,933.27	405.91	2,339.18
Existing VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.04	.02	.06
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.05	.00	.06
Tanker	Large	0.00	.03	.01	.04
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.01	.00	.01
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.11	.02	.13
Tug/Tow Boat	Small	0.00	.05	.01	.06
Totals		0.00	.32	.06	.39
Existing VTS Design - Dollars					
Passenger	Small	0.00	33.20	11.18	44.38
Dry Cargo	Large	0.00	228.42	87.41	315.82
Dry Cargo	Medium	0.00	95.50	12.40	107.90
Dry Cargo	Small	0.00	306.21	24.24	330.45
Tanker	Large	0.00	165.85	51.84	217.69
Tanker	Medium	0.00	5.11	1.75	6.86
Tanker	Small	0.00	0.00	1.72	1.72
Dry Cargo Barge Tow	Small	0.00	64.55	4.40	68.95
Tanker Barge Tow	Large	0.00	1.06	.08	1.14
Tanker Barge Tow	Small	0.00	619.76	122.95	742.71
Tug/Tow Boat	Small	0.00	301.29	37.04	338.32
Totals		0.00	1,820.95	355.00	2,175.95

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Candidate VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Existing VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Existing VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix C Zone 3 Los Angeles/Long Beach, CA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
KEROSENE	.00	.00	.00	0.00	.00
ALCOHOLS	.00	.00	.00	.01	.01
BENZENE AND TOLUENE	.00	.00	.01	.01	.02
JET FUEL	.00	.00	.01	.00	.01
GASOLINE, INCL NATURAL	.00	.01	.02	.00	.03
DISTILLATE FUEL OIL	.00	.02	.04	1.15	1.22
CRUDE PETROLEUM	.02	.05	.01	.01	.09
RESIDUAL FUEL OIL	.04	.25	1.05	.95	2.29
	.07	.33	1.14	2.12	3.66
Existing Vts Design - Counts					
KEROSENE	.00	.00	.00	0.00	.00
ALCOHOLS	.00	.00	.00	.00	.01
BENZENE AND TOLUENE	.00	.00	.00	.01	.02
JET FUEL	.00	.00	.00	.00	.01
GASOLINE, INCL NATURAL	.00	.01	.02	.00	.03
DISTILLATE FUEL OIL	.00	.01	.03	.93	.98
CRUDE PETROLEUM	.02	.04	.01	.00	.07
RESIDUAL FUEL OIL	.03	.21	.86	.77	1.86
	.06	.27	.93	1.72	2.97

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix C
TABLE 18A

Zone 3 Los Angeles/Long Beach, CA
Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	7,664	0	0
1996	0	640	6,203
1997	0	582	5,714
1998	0	529	5,262
1999	0	481	4,845
2000	0	437	4,467
2001	0	398	4,114
2002	0	361	3,794
2003	0	329	3,498
2004	0	299	3,225
2005	0	272	2,976
2006	0	247	2,743
2007	0	224	2,531
2008	0	204	2,334
2009	0	185	2,153
2010	0	169	1,989
	7,664	5,357	55,848

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	7,664	0	0
1996	0	814	7,881
1997	0	814	7,985
1998	0	814	8,089
1999	0	814	8,193
2000	0	814	8,309
2001	0	814	8,418
2002	0	814	8,539
2003	0	814	8,661
2004	0	814	8,782
2005	0	814	8,917
2006	0	814	9,038
2007	0	814	9,173
2008	0	814	9,308
2009	0	814	9,444
2010	0	814	9,595
	7,664	12,203	130,333

Appendix C Zone 3 Los Angeles/Long Beach, CA
TABLE 18B Annual Benefit & Cost Streams 7/31/91
Existing VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	5,091
1997	0	0	4,690
1998	0	0	4,319
1999	0	0	3,977
2000	0	0	3,666
2001	0	0	3,376
2002	0	0	3,113
2003	0	0	2,870
2004	0	0	2,646
2005	0	0	2,442
2006	0	0	2,250
2007	0	0	2,076
2008	0	0	1,915
2009	0	0	1,766
2010	0	0	1,631
	0	0	45,828

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	6,468
1997	0	0	6,554
1998	0	0	6,639
1999	0	0	6,724
2000	0	0	6,819
2001	0	0	6,908
2002	0	0	7,007
2003	0	0	7,106
2004	0	0	7,205
2005	0	0	7,316
2006	0	0	7,415
2007	0	0	7,525
2008	0	0	7,635
2009	0	0	7,746
2010	0	0	7,869
	0	0	106,939

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles		(Port 3)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0301	101	1	American Shad	.9600	.4800	0.0000	0.0000
0301	101	81	Salmon, Chinook	2.7000	1.2000	2.4000	1.2000
0301	101	82	Salmon, Coho	.0130	.0130	.0130	.0130
0301	102	44	Striped Mullet	.0024	.0024	.0024	.0024
0301	102	83	Mackerel, Pacific	.4800	.4800	.4800	.4800
0301	102	84	Mackerel, Jack	3.5800	3.5800	3.5800	3.5800
0301	102	85	Anchovy, Pacific	1.1900	1.1900	1.1900	1.1900
0301	102	86	Herring, Sea	.9500	.9500	.9500	.9500
0301	102	86	Herring, Sea	2.2000	0.0000	2.2000	4.5000
0301	103	9	Monkfish	.5800	.5800	.5800	.5800
0301	103	50	Bonito	.0750	.1500	.0750	0.0000
0301	104	12	Tuna	0.0000	.2200	0.0000	0.0000
0301	104	13	Swordfish	.0480	.0480	.0480	.0480
0301	104	14	Shark	.0590	.0590	.0590	.0590
0301	104	14	Shark	1.7000	1.7000	1.7000	1.7000
0301	104	15	Dogfish	.0010	.0010	.0010	.0010
0301	105	87	Right-eye Flounder	4.1936	4.1936	4.1936	4.1936
0301	105	104	Flounder, Starry	1.8000	1.8000	1.8000	1.8000
0301	105	113	Left-eye Flounder	39.3581	39.3581	39.3581	39.3581
0301	106	36	Drum	52.6790	52.6790	52.6790	52.6790
0301	106	90	Rockfish	2.3243	2.3243	2.3243	2.3243
0301	106	92	Sablefish	2.8000	2.8000	2.8000	2.8000
0301	106	94	Lingcod	.2800	.2800	.2800	.2800
0301	106	95	Hake, Pacific	0.0000	0.0000	0.0000	10.7000
0301	106	96	Sea Bass	.0796	.0796	.0796	.0796
0301	106	109	Sculpin	.0159	.0159	.0159	.0159
0301	106	111	Poacher	.0011	.0011	.0011	.0011
0301	106	120	Goby	.0286	.0286	.0286	.0286
0301	106	142	Killyfish	.3559	.3559	.3559	.3559
0301	106	143	Surf Perch	7.6737	7.6737	7.6737	7.6737
0301	107	208	Blue Mussel	1.8000	1.8000	1.8000	1.8000
0301	107	211	Soft Clam	.4700	.4700	.4700	.4700
0301	107	220	Abalone	.8125	.8125	.8125	.8125
0301	108	217	Crab	.0850	.0850	.0850	.0850
0301	108	219	Lobster, Spiny	.0300	.0300	.0300	.0300
0301	108	221	Crab, Dungeness	.3200	.3200	.3200	.3200
0301	108	222	Shrimp, Pacific	2.4000	2.4000	2.4000	2.4000
0301	109	223	Squid, Pacific	.4800	.4800	.4800	.4800
0302	101	1	American Shad	.9600	.4800	0.0000	0.0000
0302	101	81	Salmon, Chinook	2.7000	1.2000	2.4000	1.2000
0302	101	82	Salmon, Coho	.0130	.0130	.0130	.0130
0302	102	44	Striped Mullet	.0024	.0024	.0024	.0024
0302	102	83	Mackerel, Pacific	.4800	.4800	.4800	.4800
0302	102	84	Mackerel, Jack	3.5800	3.5800	3.5800	3.5800
0302	102	85	Anchovy, Pacific	1.1900	1.1900	1.1900	1.1900
0302	102	86	Herring, Sea	.9500	.9500	.9500	.9500
0302	102	86	Herring, Sea	2.2000	0.0000	2.2000	4.5000
0302	103	9	Monkfish	.5800	.5800	.5800	.5800
0302	103	50	Bonito	.0750	.1500	.0750	0.0000
0302	104	12	Tuna	0.0000	.2200	0.0000	0.0000
0302	104	13	Swordfish	.0480	.0480	.0480	.0480
0302	104	14	Shark	.0590	.0590	.0590	.0590
0302	104	14	Shark	1.7000	1.7000	1.7000	1.7000

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles		(Port 3)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0302	104	15	Dogfish	.0010	.0010	.0010	.0010
0302	105	87	Right-eye Flounder	4.1936	4.1936	4.1936	4.1936
0302	105	104	Flounder, Starry	1.8000	1.8000	1.8000	1.8000
0302	105	113	Left-eye Flounder	39.3581	39.3581	39.3581	39.3581
0302	106	36	Drum	52.6790	52.6790	52.6790	52.6790
0302	106	90	Rockfish	2.3243	2.3243	2.3243	2.3243
0302	106	92	Sablefish	2.8000	2.8000	2.8000	2.8000
0302	106	94	Lingcod	.2800	.2800	.2800	.2800
0302	106	95	Hake, Pacific	0.0000	0.0000	0.0000	10.7000
0302	106	96	Sea Bass	.0796	.0796	.0796	.0796
0302	106	109	Sculpin	.0159	.0159	.0159	.0159
0302	106	111	Poacher	.0011	.0011	.0011	.0011
0302	106	120	Goby	.0286	.0286	.0286	.0286
0302	106	142	Killyfish	.3559	.3559	.3559	.3559
0302	106	143	Surf Perch	7.6737	7.6737	7.6737	7.6737
0302	107	208	Blue Mussel	1.8000	1.8000	1.8000	1.8000
0302	107	211	Soft Clam	.4700	.4700	.4700	.4700
0302	107	220	Abalone	.8125	.8125	.8125	.8125
0302	108	217	Crab	.0850	.0850	.0850	.0850
0302	108	219	Lobster, Spiny	.0300	.0300	.0300	.0300
0302	108	221	Crab, Dungeness	.3200	.3200	.3200	.3200
0302	108	222	Shrimp, Pacific	2.4000	2.4000	2.4000	2.4000
0302	109	223	Squid, Pacific	.4800	.4800	.4800	.4800
0303	101	1	American Shad	.9600	.4800	0.0000	0.0000
0303	101	81	Salmon, Chinook	2.7000	1.2000	2.4000	1.2000
0303	101	82	Salmon, Coho	.0130	.0130	.0130	.0130
0303	102	44	Striped Mullet	.0024	.0024	.0024	.0024
0303	102	83	Mackerel, Pacific	.4800	.4800	.4800	.4800
0303	102	84	Mackerel, Jack	3.5800	3.5800	3.5800	3.5800
0303	102	85	Anchovy, Pacific	1.1900	1.1900	1.1900	1.1900
0303	102	86	Herring, Sea	.9500	.9500	.9500	.9500
0303	102	86	Herring, Sea	2.2000	0.0000	2.2000	4.5000
0303	103	9	Monkfish	.5800	.5800	.5800	.5800
0303	103	50	Bonito	.0750	.1500	.0750	0.0000
0303	104	12	Tuna	0.0000	.2200	0.0000	0.0000
0303	104	13	Swordfish	.0480	.0480	.0480	.0480
0303	104	14	Shark	.0590	.0590	.0590	.0590
0303	104	14	Shark	1.7000	1.7000	1.7000	1.7000
0303	104	15	Dogfish	.0010	.0010	.0010	.0010
0303	105	87	Right-eye Flounder	4.1936	4.1936	4.1936	4.1936
0303	105	104	Flounder, Starry	1.8000	1.8000	1.8000	1.8000
0303	105	113	Left-eye Flounder	39.3581	39.3581	39.3581	39.3581
0303	106	36	Drum	52.6790	52.6790	52.6790	52.6790
0303	106	90	Rockfish	2.3243	2.3243	2.3243	2.3243
0303	106	92	Sablefish	2.8000	2.8000	2.8000	2.8000
0303	106	94	Lingcod	.2800	.2800	.2800	.2800
0303	106	95	Hake, Pacific	0.0000	0.0000	0.0000	10.7000
0303	106	96	Sea Bass	.0796	.0796	.0796	.0796
0303	106	109	Sculpin	.0159	.0159	.0159	.0159
0303	106	111	Poacher	.0011	.0011	.0011	.0011
0303	106	120	Goby	.0286	.0286	.0286	.0286
0303	106	142	Killyfish	.3559	.3559	.3559	.3559
0303	106	143	Surf Perch	7.6737	7.6737	7.6737	7.6737

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Los Angeles (Port 3)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0303	107	208	Blue Mussel	1.8000	1.8000	1.8000	1.8000
0303	107	211	Soft Clam	.4700	.4700	.4700	.4700
0303	107	220	Abalone	.8125	.8125	.8125	.8125
0303	108	217	Crab	.0850	.0850	.0850	.0850
0303	108	219	Lobster, Spiny	.0300	.0300	.0300	.0300
0303	108	221	Crab, Dungeness	.3200	.3200	.3200	.3200
0303	108	222	Shrimp, Pacific	2.4000	2.4000	2.4000	2.4000
0303	109	223	Squid, Pacific	.4800	.4800	.4800	.4800
0304	101	1	American Shad	.9600	.4800	0.0000	0.0000
0304	101	81	Salmon, Chinook	2.7000	1.2000	2.4000	1.2000
0304	101	82	Salmon, Coho	.0130	.0130	.0130	.0130
0304	102	44	Striped Mullet	.0024	.0024	.0024	.0024
0304	102	83	Mackerel, Pacific	.4800	.4800	.4800	.4800
0304	102	84	Mackerel, Jack	3.5800	3.5800	3.5800	3.5800
0304	102	85	Anchovy, Pacific	1.1900	1.1900	1.1900	1.1900
0304	102	86	Herring, Sea	.9500	.9500	.9500	.9500
0304	102	86	Herring, Sea	2.2000	0.0000	2.2000	4.5000
0304	103	9	Monkfish	.5800	.5800	.5800	.5800
0304	103	50	Bonito	.0750	.1500	.0750	0.0000
0304	104	12	Tuna	0.0000	.2200	0.0000	0.0000
0304	104	13	Swordfish	.0480	.0480	.0480	.0480
0304	104	14	Shark	.0590	.0590	.0590	.0590
0304	104	14	Shark	1.7000	1.7000	1.7000	1.7000
0304	104	15	Dogfish	.0010	.0010	.0010	.0010
0304	105	87	Right-eye Flounder	4.1936	4.1936	4.1936	4.1936
0304	105	104	Flounder, Starry	1.8000	1.8000	1.8000	1.8000
0304	105	113	Left-eye Flounder	39.3581	39.3581	39.3581	39.3581
0304	106	36	Drum	52.6790	52.6790	52.6790	52.6790
0304	106	90	Rockfish	2.3243	2.3243	2.3243	2.3243
0304	106	92	Sablefish	2.8000	2.8000	2.8000	2.8000
0304	106	94	Lingcod	.2800	.2800	.2800	.2800
0304	106	95	Hake, Pacific	0.0000	0.0000	0.0000	10.7000
0304	106	96	Sea Bass	.0796	.0796	.0796	.0796
0304	106	109	Sculpin	.0159	.0159	.0159	.0159
0304	106	111	Poacher	.0011	.0011	.0011	.0011
0304	106	120	Goby	.0286	.0286	.0286	.0286
0304	106	142	Killyfish	.3559	.3559	.3559	.3559
0304	106	143	Surf Perch	7.6737	7.6737	7.6737	7.6737
0304	107	208	Blue Mussel	1.8000	1.8000	1.8000	1.8000
0304	107	211	Soft Clam	.4700	.4700	.4700	.4700
0304	107	220	Abalone	.8125	.8125	.8125	.8125
0304	108	217	Crab	.0850	.0850	.0850	.0850
0304	108	219	Lobster, Spiny	.0300	.0300	.0300	.0300
0304	108	221	Crab, Dungeness	.3200	.3200	.3200	.3200
0304	108	222	Shrimp, Pacific	2.4000	2.4000	2.4000	2.4000
0304	[illegible]	223	Squid, Pacific	.4800	.4800	.4800	.4800

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles Port & Subzone	Species Category	(Port 3) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0301	202	1084	Mackerel, Jack	.0100	0.0000	0.0000	0.0000
0301	202	1085	Anchovy	495.0000	5.0000	55.0000	50.5000
0301	202	1119	Sardine	.0020	0.0000	0.0000	0.0000
0301	205	1087	Slender Sole	.5000	0.0000	0.0000	0.0000
0301	205	1088	Halibut	.5000	0.0000	0.0000	0.0000
0301	205	1107	English Sole	.5000	0.0000	0.0000	5.0000
0301	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0301	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0301	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0301	205	1199	Other Larvae	54.5000	32.7000	17.8000	.2000
0301	206	1090	Rockfish	3.0000	0.0000	0.0000	3.0000
0301	206	1095	Pacific Hake	3.0000	0.0000	0.0000	0.0000
0301	206	1101	Turbot	0.0000	.5000	0.0000	.5000
0301	206	1199	Other Larvae	.2700	4.6000	10.1000	.2000
0301	206	1199	Other Larvae	16.5500	16.5500	16.5500	16.5500
0301	207	1199	Other Larvae	.0095	.0950	.0095	0.0000
0301	208	1199	Other Larvae	.1600	.4200	0.0000	0.0000
0302	202	1084	Mackerel, Jack	.0100	0.0000	0.0000	0.0000
0302	202	1085	Anchovy	495.0000	5.0000	55.0000	50.5000
0302	202	1119	Sardine	.0020	0.0000	0.0000	0.0000
0302	205	1087	Slender Sole	.5000	0.0000	0.0000	0.0000
0302	205	1088	Halibut	.5000	0.0000	0.0000	0.0000
0302	205	1107	English Sole	.5000	0.0000	0.0000	5.0000
0302	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0302	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0302	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0302	205	1199	Other Larvae	54.5000	32.7000	17.8000	.2000
0302	206	1090	Rockfish	3.0000	0.0000	0.0000	3.0000
0302	206	1095	Pacific Hake	3.0000	0.0000	0.0000	0.0000
0302	206	1101	Turbot	0.0000	.5000	0.0000	.5000
0302	206	1199	Other Larvae	.2700	4.6000	10.1000	.2000
0302	206	1199	Other Larvae	16.5500	16.5500	16.5500	16.5500
0302	207	1199	Other Larvae	.0095	.0950	.0095	0.0000
0302	208	1199	Other Larvae	.1600	.4200	0.0000	0.0000
0303	202	1084	Mackerel, Jack	.0100	0.0000	0.0000	0.0000
0303	202	1085	Anchovy	495.0000	5.0000	55.0000	50.5000
0303	202	1119	Sardine	.5000	0.0000	0.0000	0.0000
0303	205	1087	Slender Sole	.5000	0.0000	0.0000	0.0000
0303	205	1088	Halibut	.5000	0.0000	0.0000	0.0000
0303	205	1107	English Sole	.5000	0.0000	0.0000	5.0000
0303	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0303	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0303	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0303	205	1199	Other Larvae	54.5000	32.7000	17.8000	.2000
0303	206	1090	Rockfish	3.0000	0.0000	0.0000	3.0000
0303	206	1095	Pacific Hake	3.0000	0.0000	0.0000	0.0000
0303	206	1101	Turbot	0.0000	.5000	0.0000	.5000
0303	206	1199	Other Larvae	.2700	4.6000	10.1000	.2000
0303	206	1199	Other Larvae	16.5500	16.5500	16.5500	16.5500
0303	207	1199	Other Larvae	.0095	.0950	.0095	0.0000
0303	208	1199	Other Larvae	.1600	.4200	0.0000	0.0000
0304	202	1084	Mackerel, Jack	.0100	0.0000	0.0000	0.0000
0304	202	1085	Anchovy	495.0000	5.0000	55.0000	50.5000
0304	202	1119	Sardine	.5000	0.0000	0.0000	0.0000
0304	205	1087	Slender Sole	.5000	0.0000	0.0000	0.0000

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles		(Port 3)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0304	205	1088	Halibut	.5000	0.0000	0.0000	0.0000
0304	205	1107	English Sole	.5000	0.0000	0.0000	5.0000
0304	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0304	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0304	205	1113	Sand Dab	.5000	.5000	0.0000	0.0000
0304	205	1199	Other Larvae	54.5000	32.7000	17.8000	.2000
0304	206	1090	Rockfish	3.0000	0.0000	0.0000	3.0000
0304	206	1095	Pacific Hake	3.0000	0.0000	0.0000	0.0000
0304	206	1101	Turbot	0.0000	.5000	0.0000	.5000
0304	206	1199	Other Larvae	.2700	4.6000	10.1000	.2000
0304	206	1199	Other Larvae	16.5500	16.5500	16.5500	16.5500
0304	207	1199	Other Larvae	.0095	.0950	.0095	0.0000
0304	208	1199	Other Larvae	.1600	.4200	0.0000	0.0000

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles Port & Subzone	Species Category	(Port 3) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0301	111	511	Dabbling Ducks	0.0000	0.0000	0.0000	1.2191
0301	111	512	Coot, Gallinule	0.0000	0.0000	.0353	0.0000
0301	111	513	Goose	18.0000	0.0000	18.0000	36.0000
0301	111	514	Swan	1.7000	0.0000	1.7000	3.3000
0301	111	515	Diving Ducks	3.1272	3.9929	5.7244	5.9011
0301	111	516	Loon	.9894	.0883	0.0000	.4947
0301	111	517	Grebe	1.9611	.4770	1.0954	5.0000
0301	112	561	Heron, Egret, Bittern	0.0000	.3180	.0707	.3357
0301	112	571	Sandpiper, Plover, Turnstone	2.6148	1.4134	1.9788	2.4558
0301	112	572	Oystercatcher, Avocet, Stilt	.0353	0.0000	0.0000	0.0000
0301	113	530	Cormorant	1.4134	.4594	.8127	1.3781
0301	113	531	Gull	11.2721	18.0035	35.2650	19.3640
0301	113	532	Kittiwake	.4770	.0177	0.0000	.2120
0301	113	533	Tern	2.5972	.4240	4.6113	.7951
0301	113	546	Pelican	4.0459	4.4700	13.3039	.3534
0301	114	591	Kingfisher	0.0000	.0177	.0707	0.0000
0302	111	511	Dabbling Ducks	0.0000	0.0000	0.0000	1.2191
0302	111	512	Coot, Gallinule	0.0000	0.0000	.0353	0.0000
0302	111	513	Goose	18.0000	0.0000	18.0000	36.0000
0302	111	514	Swan	1.7000	0.0000	1.7000	3.3000
0302	111	515	Diving Ducks	3.1272	3.9929	5.7244	5.9011
0302	111	516	Loon	.9894	.0883	0.0000	.4947
0302	111	517	Grebe	1.9611	.4770	1.0954	5.0000
0302	112	561	Heron, Egret, Bittern	0.0000	.3180	.0707	.3357
0302	112	571	Sandpiper, Plover, Turnstone	2.6148	1.4134	1.9788	2.4558
0302	112	572	Oystercatcher, Avocet, Stilt	.0353	0.0000	0.0000	0.0000
0302	113	530	Cormorant	1.4134	.4594	.8127	1.3781
0302	113	531	Gull	11.2721	18.0035	35.2650	19.3640
0302	113	532	Kittiwake	.4770	.0177	0.0000	.2120
0302	113	533	Tern	2.5972	.4240	4.6113	.7951
0302	113	546	Pelican	4.0459	4.4700	13.3039	.3534
0302	114	591	Kingfisher	0.0000	.0177	.0707	0.0000
0303	111	511	Dabbling Ducks	0.0000	0.0000	0.0000	1.2191
0303	111	512	Coot, Gallinule	0.0000	0.0000	.0353	0.0000
0303	111	513	Goose	18.0000	0.0000	18.0000	36.0000
0303	111	514	Swan	1.7000	0.0000	1.7000	3.3000
0303	111	515	Diving Ducks	3.1272	3.9929	5.7244	5.9011
0303	111	516	Loon	.9894	.0883	0.0000	.4947
0303	111	517	Grebe	1.9611	.4770	1.0954	5.0000
0303	112	561	Heron, Egret, Bittern	0.0000	.3180	.0707	.3357
0303	112	571	Sandpiper, Plover, Turnstone	2.6148	1.4134	1.9788	2.4558
0303	112	572	Oystercatcher, Avocet, Stilt	.0353	0.0000	0.0000	0.0000
0303	113	530	Cormorant	1.4134	.4594	.8127	1.3781
0303	113	531	Gull	11.2721	18.0035	35.2650	19.3640
0303	113	532	Kittiwake	.4770	.0177	0.0000	.2120
0303	113	533	Tern	2.5972	.4240	4.6113	.7951
0303	113	546	Pelican	4.0459	4.4700	13.3039	.3534
0303	114	591	Kingfisher	0.0000	.0177	.0707	0.0000
0304	111	511	Dabbling Ducks	0.0000	0.0000	0.0000	1.2191
0304	111	512	Coot, Gallinule	0.0000	0.0000	.0353	0.0000
0304	111	513	Goose	18.0000	0.0000	18.0000	36.0000
0304	111	514	Swan	1.7000	0.0000	1.7000	3.3000
0304	111	515	Diving Ducks	3.1272	3.9929	5.7244	5.9011
0304	111	516	Loon	.9894	.0883	0.0000	.4947

APPENDIX C

ZONE 3 - LOS ANGELES/LONG BEACH, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Los Angeles		(Port 3)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0304	111	517	Grebe	1.9611	.4770	1.0954	5.0000
0304	112	561	Heron, Egret, Bittern	0.0000	.3180	.0707	.3357
0304	112	571	Sandpiper, Plover, Turnstone	2.6148	1.4134	1.9788	2.4558
0304	112	572	Oystercatcher, Avocet, Stilt	.0353	0.0000	0.0000	0.0000
0304	113	530	Cormorant	1.4134	.4594	.8127	1.3781
0304	113	531	Gull	11.2721	18.0035	35.2650	19.3640
0304	113	532	Kittiwake	.4770	.0177	0.0000	.2120
0304	113	533	Tern	2.5972	.4240	4.6113	.7951
0304	113	546	Pelican	4.0459	4.4700	13.3039	.3534
0304	114	591	Kingfisher	0.0000	.0177	.0707	0.0000

APPENDIX D

SANTA BARBARA, CA

(ZONE 4)

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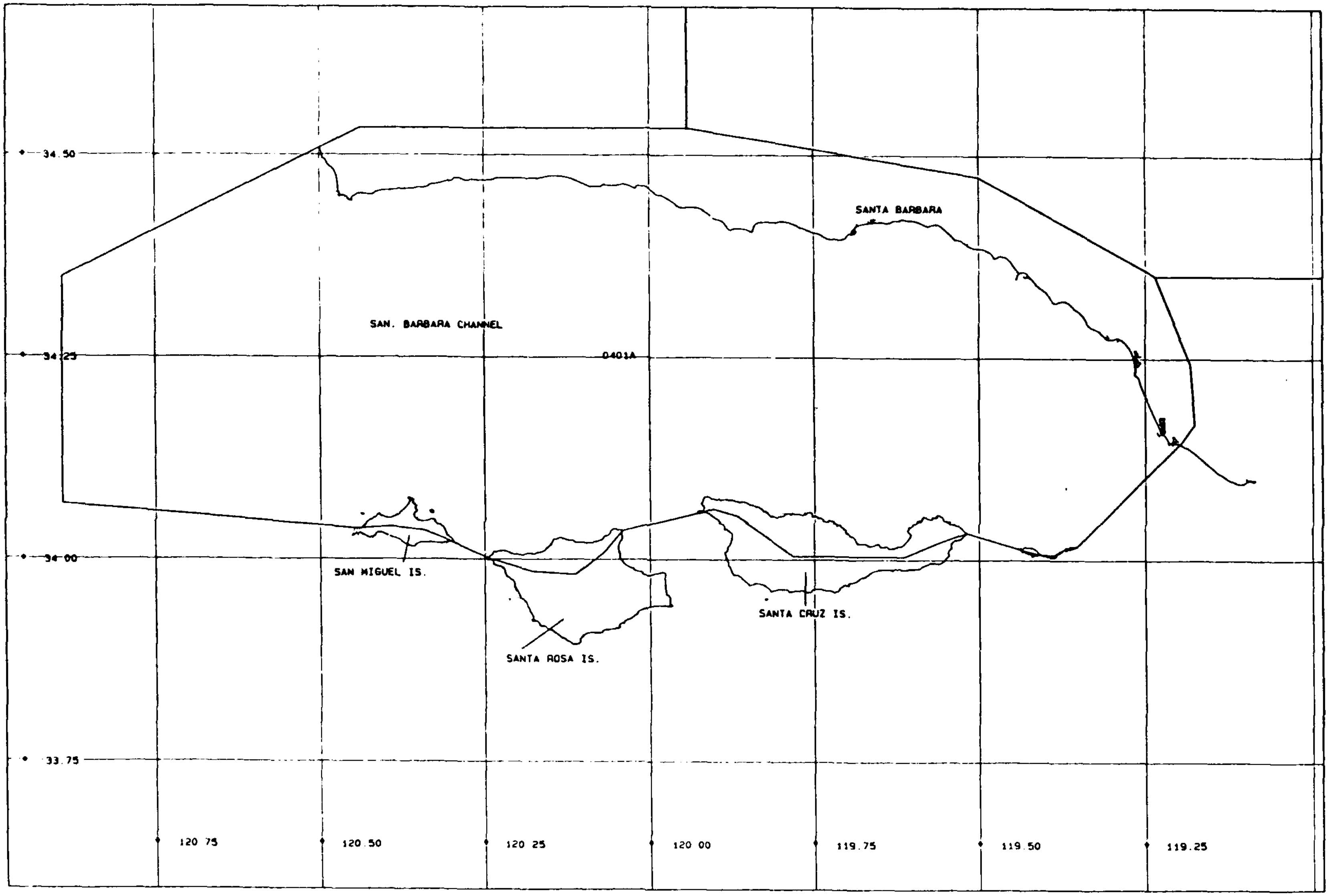
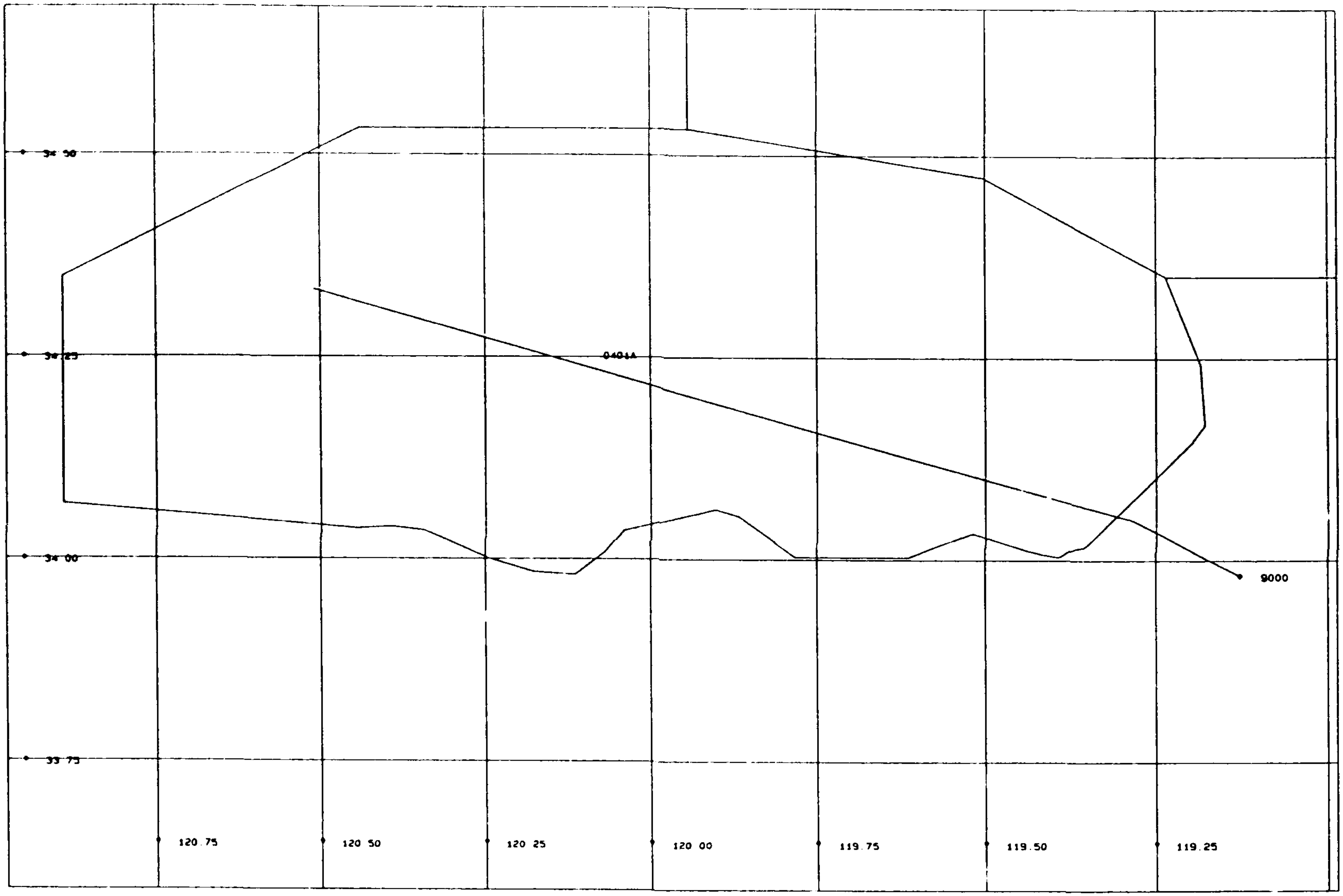
STUDY ZONE MAPS



ZONE 4 - SANTA BARBARA, CA - ZONE AND SUBZONE BOUNDARIES



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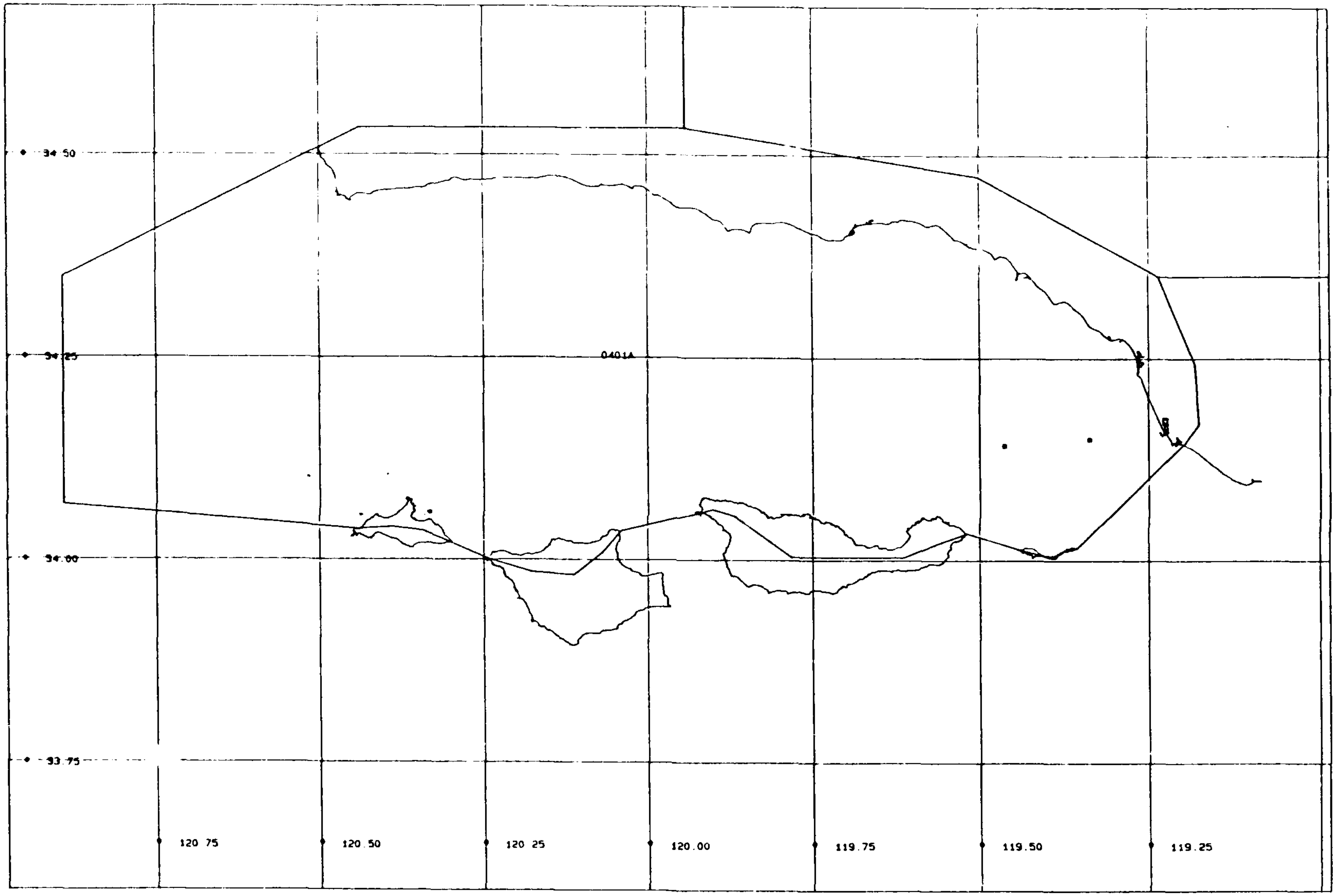
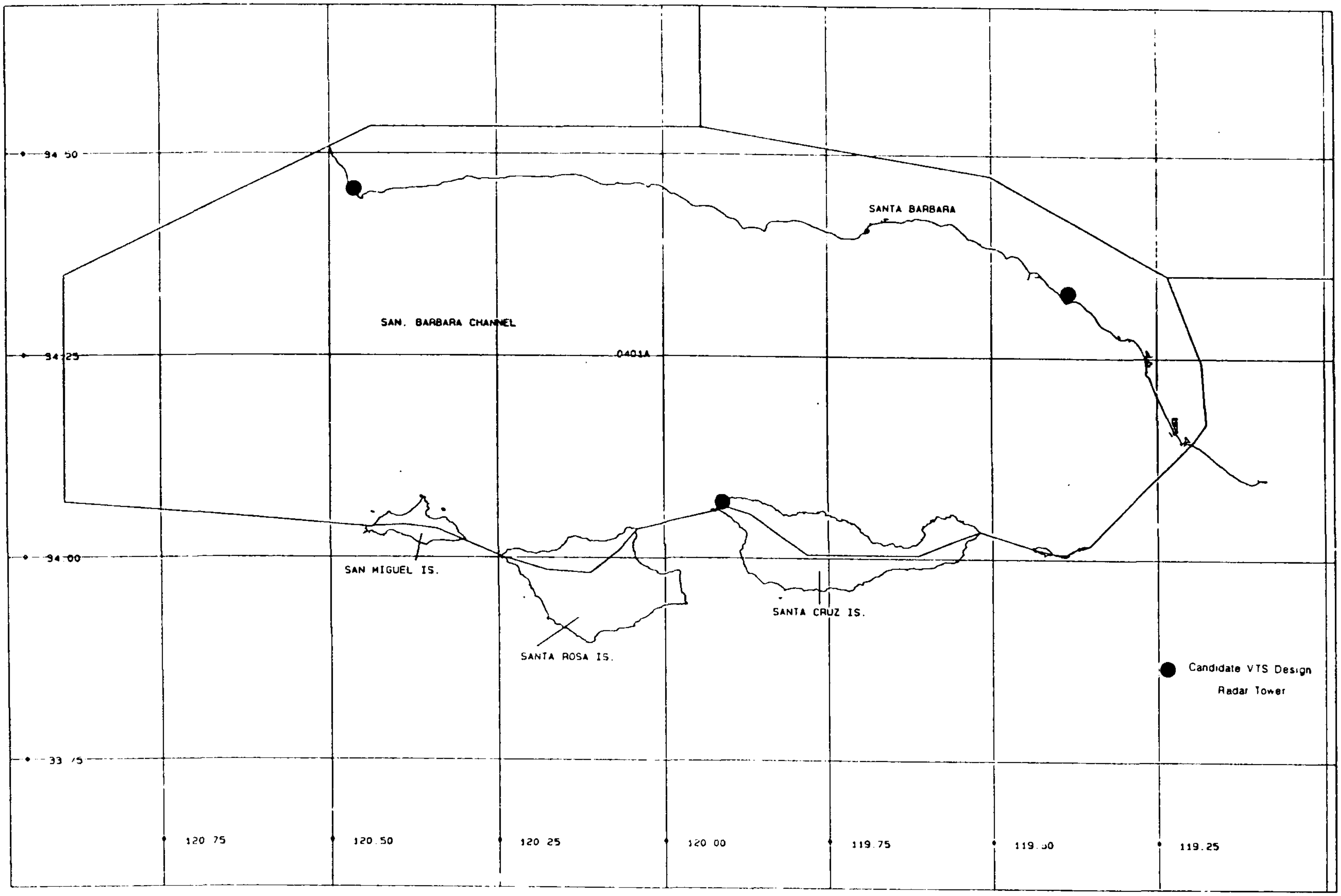


ZONE 4 - SANTA BARBARA, CA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 4 - SANTA BARBARA, CA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

SANTA BARBARA, CA

(ZONE 4)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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APPENDIX

1.0 SCOPE

This report includes a port survey (Figure 2-1) and a VTS design for Santa Barbara Channel, California. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 SANTA BARBARA CHANNEL SURVEY

2.1 INTRODUCTION

The Santa Barbara Channel area is one of significant environmental sensitivity, and of major political importance. The level of commercial shipping is not high but there is the potential for far-reaching consequences in the event of a marine incident. Although there are three areas where improved traffic management capabilities will contribute to safety and facilitation of shipping, a major consideration is to encourage public acceptance of the carriage of petroleum products and other pollutants by water.

2.2 OVERVIEW OF THE PORT

The Santa Barbara Channel is an elongated and largely sheltered body of water extending from Point Conception on the west to San Pedro Channel on the east. Although extending beyond the Channel proper, the entire length of the Santa Barbara Channel Traffic Separation Scheme is included in this study to avoid distortion of the overall picture.

Climatically, it is an area of extremes. Point Conception, for example, has a long-standing reputation as the "Cape Horn of the Pacific" (Reference 1) and with its companion, Point Arguello, has been the graveyard of many ships. The Point Conception area has been described as a transition area from the placid waters of the south to exposure to the full sweep of the Pacific Ocean. Past Point Conception, there is an immediate change in wind and sea conditions.

The Santa Barbara Channel has long been a major shipping lane serving the two Southern California ports of Los Angeles and Long Beach. It is also the site of major offshore oil exploration and extraction operations. This has given rise to a number of offshore production platforms, some located immediately adjacent to the Santa Barbara Traffic Separation Scheme (TSS).

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			
II										2	1		1						
III										1	1	1							

FIGURE 2-1. SANTA BARBARA, CA, CHANNEL SURVEILLANCE SURVEY

The Channel Islands which form the southern "bank" of the Channel have been incorporated into a Marine Sanctuary administered by the National Oceanic and Atmospheric Agency (NOAA) and the waters between the islands and the mainland are extensively used by recreational boaters and fishermen. Kelp harvesting and sea urchin gathering are two relatively unique fisheries supported by the region. Seismic survey work from small ships is continually in progress, particularly in that portion of the Channel westward of Anacapa Light.

Port Hueneme is a small but essential port, serving as a port for U. S. military deployments. The northern coastline is also the site of a number of offshore oil terminals, where petroleum is moved between ship and shore by submerged pipeline. Off shore platform support vessels operate from Ventura, Gaviota and to a lesser extent from Santa Barbara. Marinas serving recreational boating are concentrated in Santa Barbara, Ventura, Channel Islands Harbor and the small harbors of Santa Monica Bay. The area is a magnet that draws weekend boaters from Los Angeles/Long Beach and by trailerable boat from all over southern California. The Pacific Missile Test Center is headquartered at Point Mugu and uses much of the area south of the Channel Islands as a testing range.

From the beginning of offshore operations within the Channel there has been concern about pollution and about the likelihood of a major environmental catastrophe resulting from collision between a ship and an oil platform. Following the oil crisis of 1973, oil companies actively sought to expand drilling operations. Considerable effort was expended by state and federal organizations to resolve the conflicts which arose over preservation of the shipping lanes and oil development. A Port Access Route Study, completed in 1981, established the current rules regarding platform siting relative to the TSS. The results of this study were obtained from a simulator-based study of siting risks conducted by the Maritime Administration for the California Coastal Commission.

Large ship movement within the TSS is an interesting study in traffic dynamics. On the offshore end, SSW of Point Conception, the TSS terminates without a Precautionary Area at a point where coastwise traffic between Los Angeles/Long Beach and other U. S. ports makes a nearly 90 degree turn. That area also corresponds to the point of landfall or departure for Los Angles/Long Beach traffic to and from the Orient and is a transit area for coastwise shipping outside the Channel Islands. Near the juncture of this area lie three offshore platforms. Enclosure 1, prepared using lapsed time photography by the U. S. Coast Guard (USCG) Research and Development Center, was included with the Southern California Port Access Route Study conducted in 1981 (Reference 2), and clearly depicts the nature of the traffic pattern. Inside the Santa Barbara Channel itself, the majority of large ship traffic conforms to the TSS. Surprisingly, that

traffic follows a diurnal pattern set by the operations of the ports of Los Angeles/Long Beach (LA/LB). Traffic moves Eastbound from late evening to early morning, to position the ships at the LA/LB Precautionary Area between 0430-0800. LA/LB tends to discourage shipping near the close of the work day which causes Westbound traffic to enter the eastern portion of the Channel during the early evening. This pattern tends to minimize interferences between shipping and other forms of maritime traffic. This reduces management requirements to on-board navigation and observation of the Rules of the Road.

The Santa Monica Basin portion of the Santa Barbara TSS terminates at the LA/LB Precautionary Area and so the eastbound TSS is effectively a major traffic queue for those ports. Early contact with and advice to inbound ships is required for effective traffic management in the LA/LB area. The queuing process will become increasingly important as port development leads to increased traffic, congested waterways and limited anchorages.

2.3 EXISTING TRAFFIC MANAGEMENT

Traffic control measures within the Santa Barbara Channel area consist principally of an IMO-sanctioned Traffic Separation Scheme covering the area between Point Fermin and Point Conception. At its narrowest, NE of Anacapa Island, the TSS is approximately 5 miles wide. The minimum depth encountered in the TSS is 40 fathoms. Vessels in the area are subject to the 72COLREGS (Reference 3). Port Hueneme Port Control Authority is vested in the U. S. Navy. The Los Angeles/Long Beach Marine Exchange establishes communication with most eastbound ships in the vicinity of the Santa Monica Basin. They coordinate ship arrival in LA/LB and provide traffic information for the ports.

A radar surveillance and communications system has been installed in the Point Conception approaches to manage traffic. There are three separate platforms there: Platforms Hidalgo and Hermosa operated by Chevron; and, Harvest operated by Texaco. By agreement between Chevron and Texaco, Radio Holland has installed and operates a radar on Harvest. The primary purpose of this installation is to prevent collisions by vessels with any of the three platforms.

The stated objective of the radar system is to "monitor vessel movements and to notify vessels of the locations of the platforms (Harvest, Hildago and Hermosa). AT NO TIME WILL THE SYSTEM OPERATOR PROVIDE NAVIGATIONAL ASSISTANCE TO VESSELS BEING TRACKED BY THE SYSTEM OR TAKE ANY ACTION TO PREVENT VESSEL TO VESSEL COLLISIONS" (Reference 4). The operator attempts communication with any vessel entering the 24-mile monitoring radius, if it closes to within 10 nautical miles of a platform location and no communications have been established, and/or when

a vessel's predicted Closest Point of Approach (CPA) is less than 1-nautical mile. Communications are conducted primarily on CH13, with CH16 used to call vessels that have not responded or who are known not to be guarding CH13. There is no advance notification or arrival information available to the operator on Harvest. The Texaco- established standard is to ask that vessel traffic clear all three platforms by at least 2 miles (CPA). The radar scope includes a misshapen range ring which depicts ranges of 10 miles from each of the platforms. Also depicted on the radar monitor is a graphic extension of the Santa Barbara TSS past the platforms, a circular "Precautionary Area" and a traffic scheme continuing North toward San Francisco. This is an adaptation created by Radio Holland to assist their effort and does not represent any official or unofficial extension of the existing TSS.

The operator notifies the Platform Foreman of a possible dangerous situation when no communications have been established and a vessel has a predicted CPA of less than 0.5 nm and time to CPA is within 30 minutes. Other levels of alert are transmitted to a standby vessel which is dispatched to intercept. A Platform Emergency may be declared when no communications have been established with a vessel having a CPA of 0.25 nm and a time to CPA of less than 10 minutes.

The auto acquisition and tracking features of the radar system causes an alarm when a vessel enters the "monitored zone". Data on every vessel tracked is entered on a hand prepared log sheet. Many vessels will not respond to calls from the operator and as long as they stay outside the 10-nm ring, attempts to establish communications are not pursued. Some vessels (less than 5%) cut inside between the platforms and the shoreline. Most of these vessels will communicate with Harvest.

Certain language problems prevent effective communication between the radar operator and transiting vessels. There have been some nuisance complaints concerning the Harvest operator talking too much on CH16 and CH13 so procedure is to limit communications with vessels having CPA's 5-nm miles or greater. Many vessels call in voluntarily, especially large tankers and tugs with tows. Vessels smaller than a workboat are not monitored.

VHF-FM Channels 10, 13 and 16 are continuously recorded on a 6 channel, 24-hr tape recorder along with time and date (on two channels). Video recordings are made continuously at one-minute intervals and the tapes are retained 45 to 60 days. The USCG, among others, have been permitted to review these recordings pursuant to marine investigations.

A Petroleum Industry Consortium, headed by EXXON, has discussed the possibility of extending radar coverage (16-nm circles) through the rest of the Santa Barbara Channel, with one radar

ashore at the Gaviota Terminal and another further south near Carpenteria. If implemented, the plan would bring the radar data back to one central location with integration into a NORCONTROL VOC 90 system for display and management.

Two Harvest radars are 60Kw, S-Band units with 12-ft antennas. S-band was chosen to give best performance with weather although a coupled X-band device would have provided better close-in target definition. The antennas (scanners) are on opposite sides of the platform and the radar signals are integrated into one VOC 80A daylight display (X,Y) manufactured by NORCONTROL. The maximum range of the radar is 96 nautical miles. The VOC console is LAN capable and has room for 8 tracker inputs (sensors) - with NOR closed architecture interfaces. Data management is provided with display on a separate screen and information from a centralized data base.

The Harvest radar offers interesting potential for incorporation into a VTS scheme for the Santa Barbara Channel. The radar information could be processed for transmitting to LA/LB VTS or an industry support network could be incorporated into an overall VTS envelope managed by the USCG.

2.4 VESSEL TRAFFIC

Through vessel traffic consists of 24-25 ships per day, counting traffic in both directions. Major oil carriers now go south of the Santa Barbara Channel and will undoubtedly continue to do so in the foreseeable future. This has reduced the number of transits significantly from those of the late-1980's.

2.5 ENVIRONMENTAL SENSITIVITY

A major environmental feature of the Santa Barbara Channel is that its southern boundary is entirely enclosed in a marine sanctuary administered by the National Oceanic and Atmospheric Agency (NOAA). Its boundaries and relationship to the Channel are clearly shown in Enclosure 2. Oil spill trajectories, generated to support the 1981 Port Access Route Study show that, in general, releases of oil or other pollutants in the waters of the Channel will most likely enter the Sanctuary area. Representative trajectory information is included in Enclosure 3.

Environmentalists, including NOAA personnel, have indicated that a major spill would be most devastating to aquatic life within the sanctuary if it came ashore on the south coast of the islands. The sandy beaches there would also be particularly hard to clean up. The likelihood of oil coming ashore is, however, less likely there than it is on the northern side. The relatively sheltered northern side appears to offer fewer cleanup problems.

Preservation of the marine sanctuary and the mainland beaches is a major political issue in the region, and feelings run high about avoiding risks. The short-term effects of a pollution incident would have a major economic impact upon the recreational industry. Longer term effects depend upon a number of variables, and NOAA has a significant amount of documentation discussing the problems.

2.6 PORT SUB-ZONES

The area was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 4).

Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous. Three distinct sub-zones are identified.

2.6.1 Sub-zone I - Point Conception Approaches (NOAA Chart 18720)

This Sub-Zone extends to sea westward of a line drawn southward from Point Conception Light.

It embraces an area of distinct climatic change, and is a traffic focal point. Offshore exploration occurs within the area and production drilling facilities are sited there. It is classified as "open-complex".

2.6.2 Sub-zone II - Santa Barbara Channel

This sub-zone extends from a line drawn southward from Point Conception eastward to a line drawn between San Pedro Point (Santa Cruz Island) and Port Hueneme Light.

Few traffic management problems are foreseen in this sub-zone because traffic flow is generally in well-defined lanes and meeting other traffic is limited by transit schedules. It is classified as "confined-simple", with the confinement resulting from the proximity of the Channel Islands and offshore platforms.

2.6.3 Sub-zone III - Santa Monica Basin

This sub-zone extends eastward from a line drawn between San Pedro Point (Santa Cruz Island) and Port Hueneme Light to a line drawn due south from Point Fermin Light.

The sub-zone is considered to be confined-simple, with the "confined" aspect introduced by the proximity of the TSS to Anacapa Island at the sub-zone's western extremity. Eastbound ships must exercise caution in navigation to insure that they are properly positioned before turning in conformance with the TSS.

The sub-zone constitutes a portion of the LA-LB traffic queue, providing the opportunity to adjust arrival times to avoid congestion in the Precautionary Area. The queuing aspect will become increasingly important as congestion increases at LA-LB, and with the elimination of anchorages through port development.

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

2.7.1 PAI I-1. Point Conception Approaches

The Point Conception Approaches represent a "mixing bowl" for marine traffic, with risk of collision directly related to traffic density and weather conditions. In addition to ship/ship collision, the potential exists for collision with one of the three offshore platforms sited there. In addition to the risk to life and property, prevailing winds and currents make it inevitable that any pollutant released by an accident would fetch up in the Marine Sanctuary area.

2.7.2 PAI III-1. Anacapa Island

The proximity of Anacapa Island to the eastbound lane of the TSS, and the southerly turn of the TSS just east of the island, introduces a need for accuracy in navigation. Although the level of risk is undoubtedly low, an early turn could result in grounding.

2.7.3 PAI III-2. Santa Monica Basin

Management of traffic in the sub-zone is an important element of the regulation/management of LA-LB traffic. Proper advice, primarily to adjust arrival times, offers a potential solution to some of the LA-LB traffic management concerns.

TABLE 2-1. PROBLEM AREA IDENTIFIERS

PAI # LOCATION	PROBLEM/POTENTIAL PROBLEM	MANAGEMENT REQUIREMENT
I-1 Point Conception approaches	Collisions between ships on random headings; collision with offshore platform	Advise shipping of activities as appropriate Traffic regulation procedures
III-1 Anacapa Is.	Prevention of grounding due to faulty navigation or early turn	Monitor shipping and provide appropriate warnings/advise
III-2 Santa Monica Basin	Regulation of LA/LB queuing necessary to avoid congestion in the Precautionary Area	Provide speed direction to shipping as required Traffic regulation procedures

3.0 SANTA BARBARA CHANNEL VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Santa Barbara Channel is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 5). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the channel survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Santa Barbara Channel VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumption are as follows:

- The Los Angeles/Long Beach (LA/LB) Harbors have an existing VTS system.

- The weather is generally excellent, with good visibility and sheltered from the most severe weather by the shoreline.

- Most traffic occurs at night due to the LA/LB procedures.

- Loran-C coverage is excellent with good signal strengths and crossing angles.

- The land areas provide excellent radar reflectors.

- Visual navigation in this area is excellent with more than sufficient landmarks and visual aids.

- The combination of vessels in this VTS zone is limited. The major activity is comprised of deep-draft vessels which move in a Traffic Separation Scheme (TSS) with little interference from other classes of vessels.

- This VTS zone is considered part of the approach to LA/LB.

- The overall traffic density is light with approximately twelve vessel movements in each direction per day.

o This VTS zone differs substantially from others in that it is not a harbor or a port but mainly an area of vessel transit. The major vessel problem is safe navigation in a TSS.

o The accident rate is very low.

o The three existing offshore oil platforms maintain an active traffic safety monitoring program. Since these platforms are outside of the defined VTS zone, they will be excluded from further design consideration

3.2 DESIGN DECISIONS

3.2.1 General

Since this area is not a port and the VTS problem involves the safe navigation of deep-draft vessels through TSS fairways with little or no interaction with other vessel types, excellent visual and electronic navigation information is available to mariners. Traffic through this zone is tied to the operation of the LA/LB Harbor because it represents the northern approach to and departure from those ports. Because this area is critical to the management of the LA/LB Harbor's approach queue, this design is considered to be part of the LA/LB VTS zone management solution. This entire VTS zone therefore properly represents one additional control sector for the LA/LB VTS system.

3.2.2 Sector 1 -- Sub-zones I, II, and III

3.2.2.1 Discussion

As previously discussions, these sub-zones represent the northern entrance to and exit from the LA/LB Harbor and must be part of the management solution of these ports. There are no significant navigation problems and the vessel interactions are limited to deep-draft vessels. The area is quite environmentally sensitive due to the presence of the Channel Island's Marine Sanctuary. Although not required for current traffic management, any Automatic Dependent Surveillance (ADS) information available from deep-draft ships would be useful to the Vessel Traffic Center (VTC).

3.2.2.2 Design

The solution for all three sub-zones in this sector is dependent in nature and involves extensive procedural reporting and active communications monitoring. To achieve this capability the following hardware is located in this zone (all VTS communications are on the LA/LB VTS frequency):

o Port Hueneme. A communications/meteorological facility is installed near Port Hueneme and will

consist of Module 10 and 11 VHF facilities and a Module 12 meteorological facility. This combined high/low radiated power communications facility will provide effective communications coverage with minimum interference.

o Point Conception Area. An identical communications/meteorological facility to Port Hueneme is required in the Point Conception area to insure complete communications coverage.

3.2.3 Vessel Traffic Center

Operation of the Santa Barbara of the VTS zone as an additional control sector in the LA/LB Harbor VTS system requires the following additions to the LA/LB VTC.

- o One full-time watchstander

- o One sector console with additional dead-reckoning software to effectively present the data reported.

- o One communications control panel.

- o Additional audio/video recording equipment.

This additional console is to have all of the features of the LA/LB VTS control consoles. These are:

3.2.3.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block

diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Volume III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Santa Barbara Channel VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware

VESSEL TRAFFIC CENTER	(x $1000) Non-recurring	10-yr. Recurring
Sector Console	200	100
Comms Console	50	10
Recording Equipment	25	10
SCADA Equipment--2 sites	50	10
Additional Software	100	20
SUB-TOTAL	425	150
<u>Port Hueneme Site</u>		
Module 10 VHF	19	13
Module 11 VHF	48	20
Module 12 Met	20	5
SUB-TOTAL	87	38

Point Conception Site		
Module 10 VHF	19	13
Module 11 VHF	48	20
Module 13 Met	20	5
SUB-TOTAL	87	38
Total Hardware Costs		
VTC (LA/LB)	425	150
Port Hueneme	87	38
Point Conception	87	38
TOTAL	599	226

3.3.3 Total Project Costs (x$1000)

Hardware	$600
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	300
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no problem	60
Spares & Training (10%)	60
Civil Engineering Assumptions: VTC Modifications, Two Comms towers,2 remote comms installations, land acquisition	500
PROJECT ESTIMATE:	$1520
Data Base Management System(Add on LA?LB)	50
TOTAL:(non-recurring)	$1570

TEN-YEAR O&M RECURRING

Hardware	226
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
TOTAL;(recurring) (10-year life)	$2726
TOTAL 10-YEAR PROJECT COST:	$4296

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2. Port Access Route Study, Study Area 22, CCGD11(m) ltr 16650/PARS of 12 June 1981.

3. Platform Harvest Radar Operating Instructions, Texaco, undated, pg. III-1.

4. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, Ppg. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING SURVEILLANCE EQUIPMENT

SANTA BARBARA (Including 3 Radars and Separate VTC)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (2 workstations)		500
Comms Console	50	
Recording Equipment	25	
SCADA Equipment (3 radar sites)	100	
Sub-total:	675	300
Sub-zone 1--Port Hueneme Site		
1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	487	438
Sub-zone II--Santa Cruz Site		
1 Module 3 radar	400	400
1 Module 10 VHF	19	13
Sub-total:	419	413
Sub-zone III--Point Conception Site		
1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	20	5
Sub-total:	487	438
TOTAL HARDWARE COSTS:	2068	1589

Santa Barbara (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

Hardware	$2068
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1034
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no problem	207
Spares & Training (10%)	207
Civil Engineering Assumptions: VTS in Port Hueneme, 2 comms towers, 3 remote comms installations, land acquisition, good remote access, no roads 3 radar installations	1500
PROJECT ESTIMATE:	5016
Data Base Management System	300
TOTAL: (non-recurring)	$ 5316

2.2 RECURRING (10 YEAR)

Hardware	1589
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 5089
TOTAL 10-YEAR PROJECT COST:	$10405

Comments:

1. Costs reflect 3 radars which were not included in the original NAVCOM design.

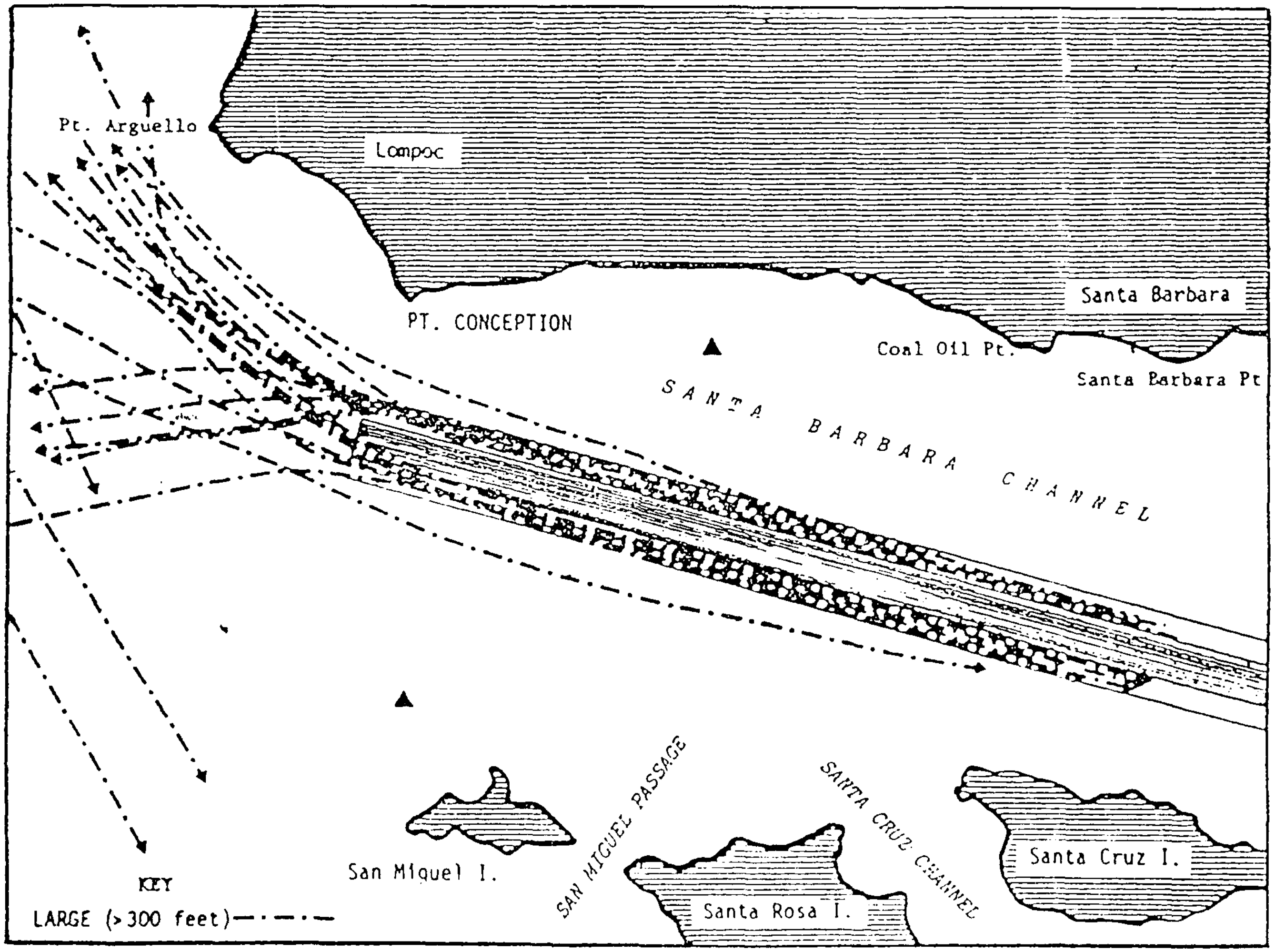
Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			
II			2							2	1		1						
III			1							1	1	1							

SANTA BARBARA, CA SURVEILLANCE SURVEY

ENCLOSURE 1

EXTRACTS FROM PARS STUDY

POINT CONCEPTION AREA

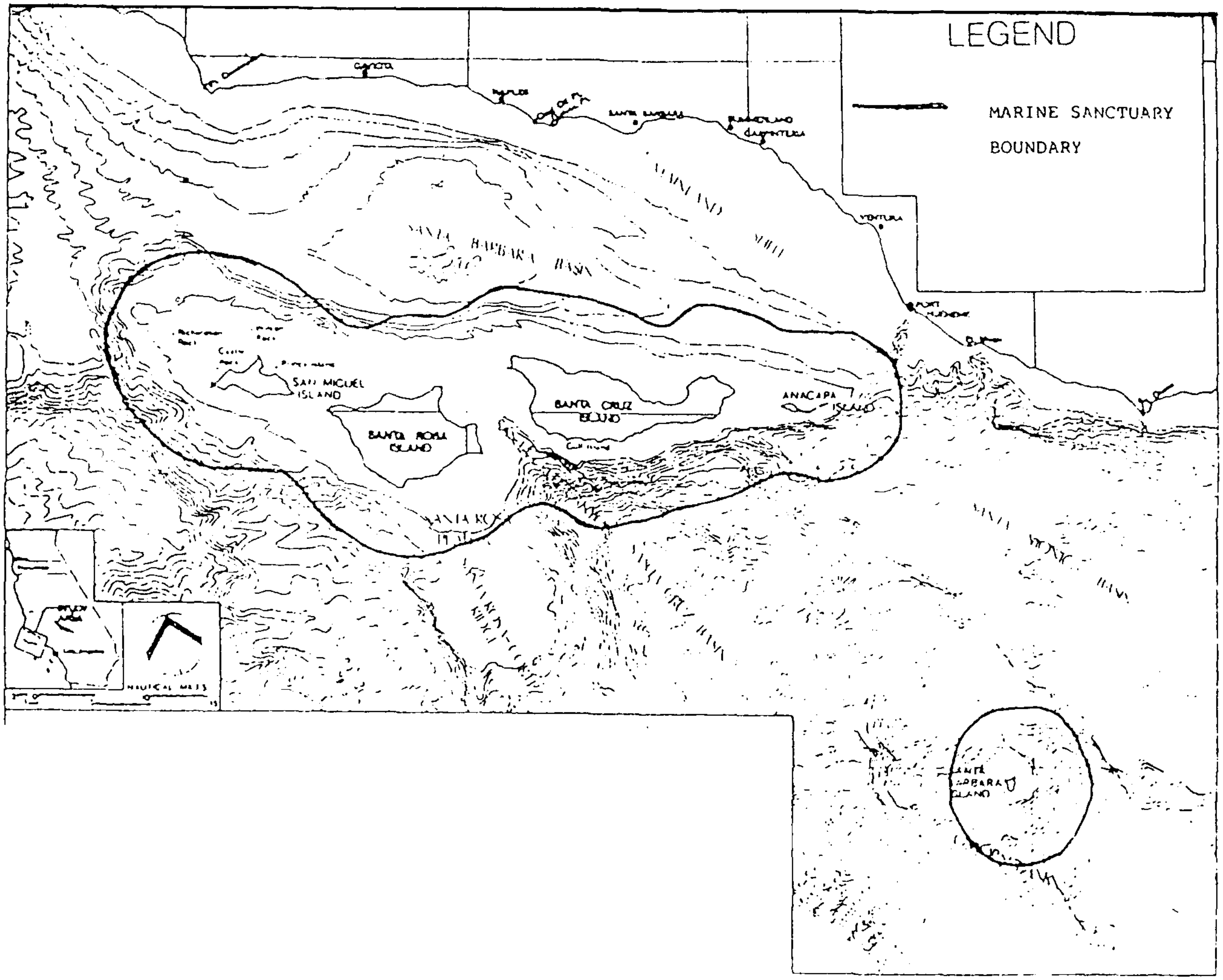


ROUTE IDENTIFICATION AT POINT CONCEPTION, 0000-1200, 3 MARCH 1977

ENCLOSURE 2

CHARTLET

CHANNEL ISLANDS MARINE SANCTUARY

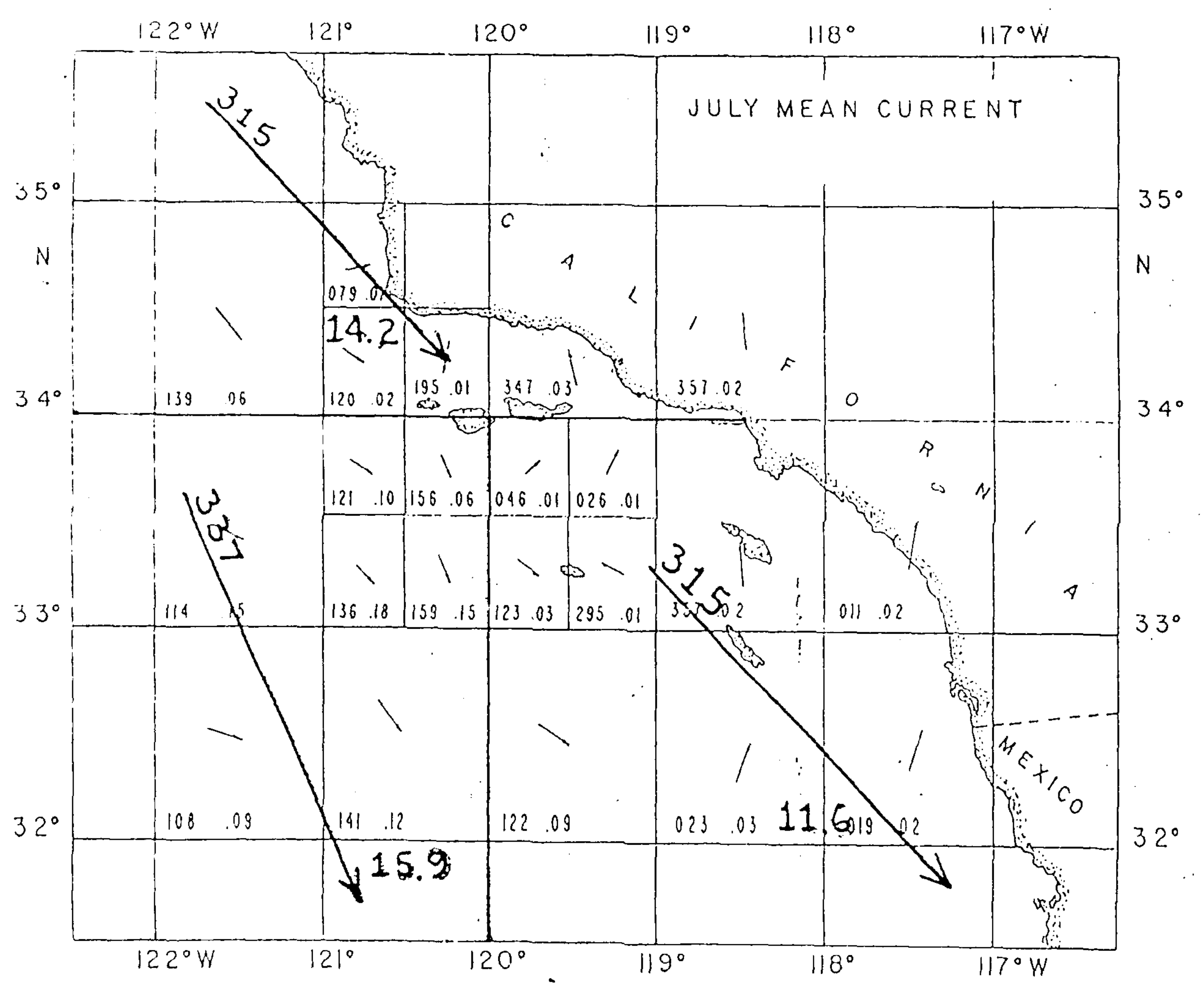


CHANNEL ISLANDS MARINE SANCTUARY

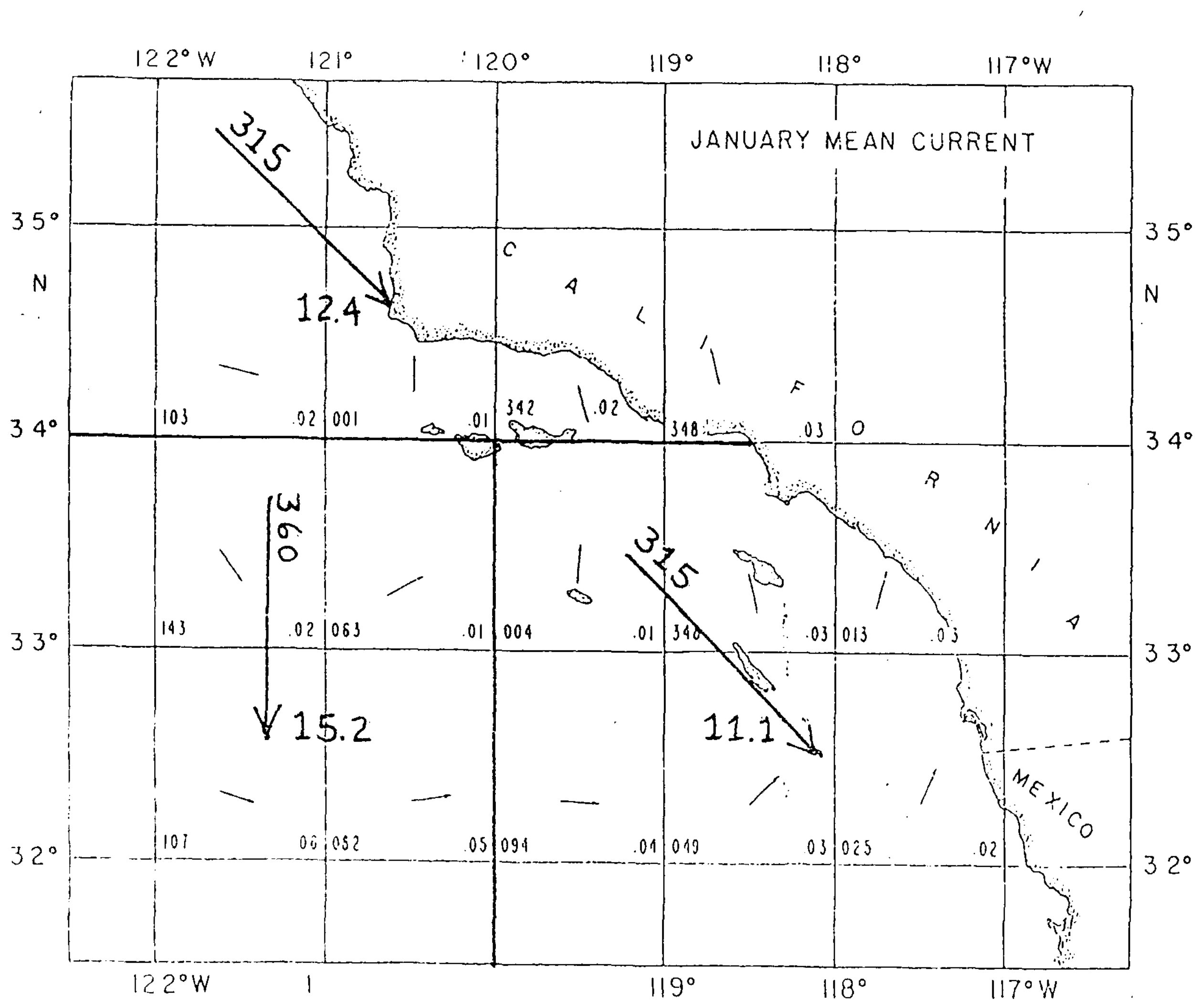
ENCLOSURE 3

EXTRACTS FROM PARS STUDY

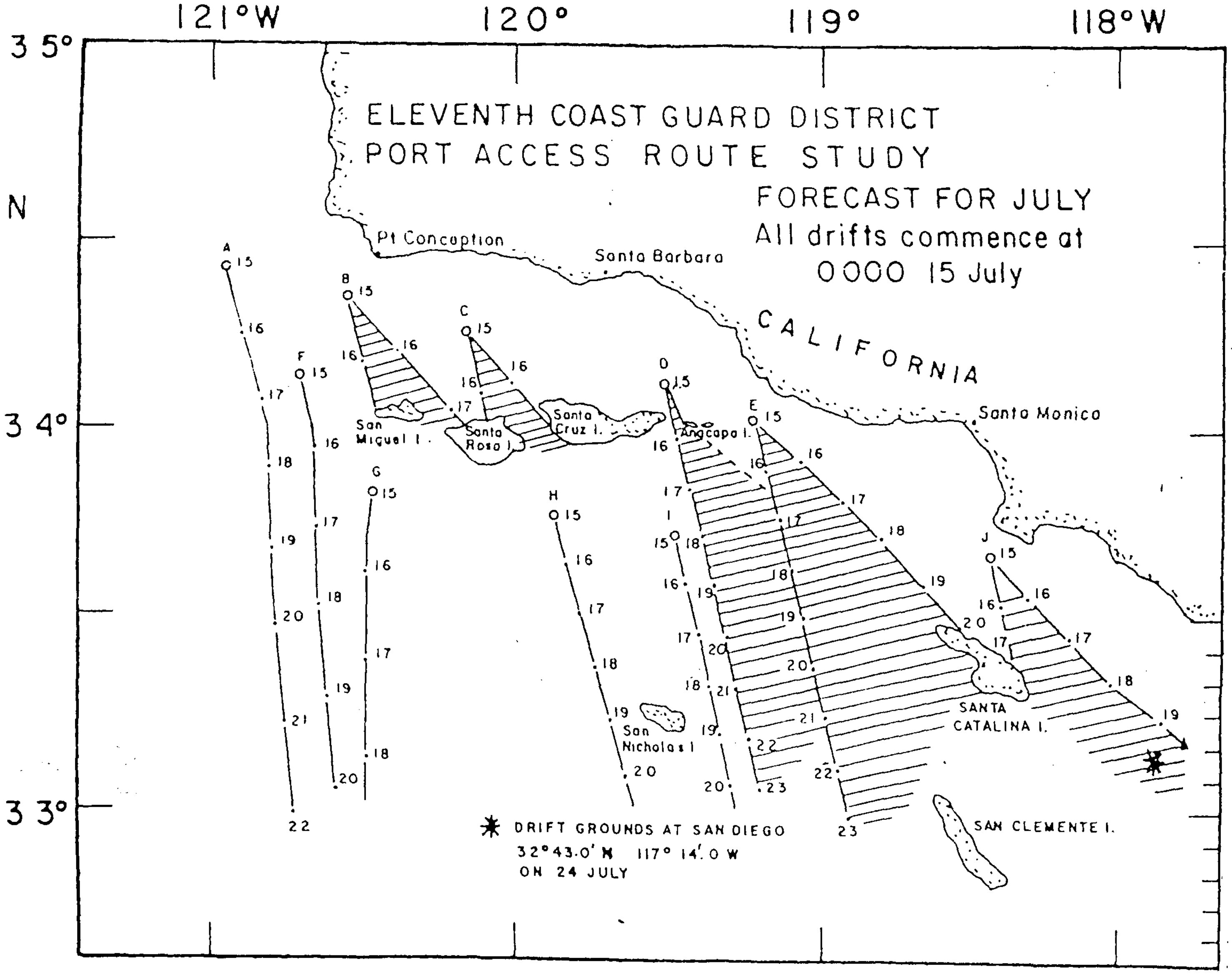
SPILL TRAJECTORIES



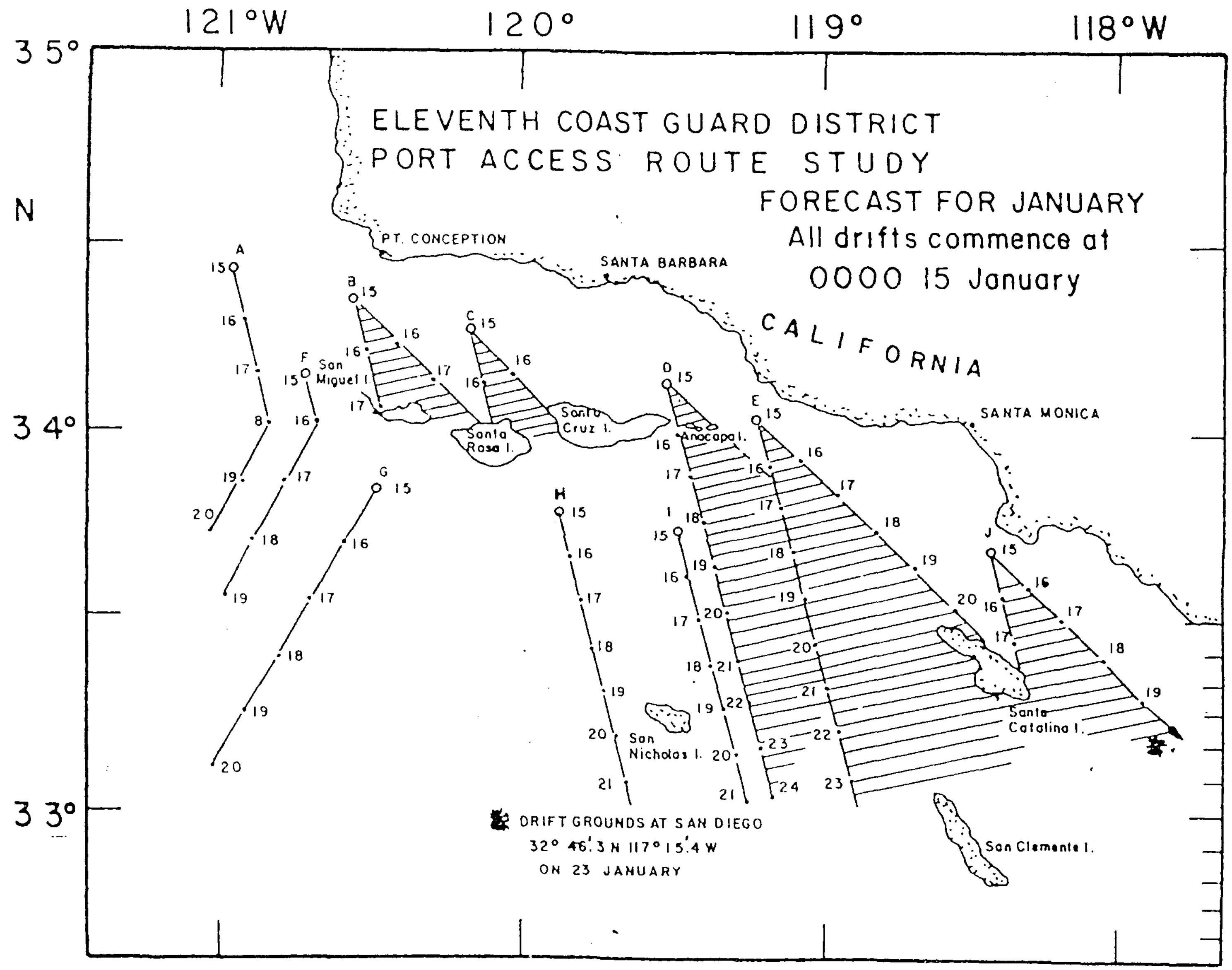
VALUES INDICATED ARE CLIMATOLOGICAL WIND DATA



VALUES INDICATED ARE CLIMATOLOGICAL WIND DATA



ELEVENTH COAST GUARD DISTRICT PORT ACCESS ROUTE STUDY



ELEVENTH COAST GUARD DISTRICT PORT ACCESS ROUTE STUDY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix D Zone 4 Santa Barbara, CA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone	401A	
9000	A	Santa Barabara Ship Channel

Appendix D Zone 4 Santa Barbara, CA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 401A Open Area off coast

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,017,749	0	0	0	2,017,749
2	FOREST PRODUCTS	62,315	0	0	0	62,315
3	FISHERIES PRODUCTS	129,064	0	0	0	129,064
4	MINING PRODUCTS, NEC	2,490,741	0	0	0	2,490,741
5	PROC. FOODS & MFTRS, NEC	23,056,232	0	1,386	0	23,057,618
6	WASTE OF MANUFACTURING	2,557,771	0	4	0	2,557,775
1311	CRUDE PETROLEUM	0	23,619,965	0	2,154	23,622,119
1492	SULPHUR, DRY	452,084	0	0	0	452,084
2810	SODIUM HYDROXIDE (CAUSTI	31,429	0	0	0	31,429
2811	CRUDE PROD-COAL TAR-PET	13,954	0	0	0	13,954
2813	ALCOHOLS	0	47,658	0	64	47,722
2817	BENZENE AND TOLUENE	0	67,001	0	210	67,211
2871	NITROGEN CHEM FERTILIZER	13,381	4,724	0	0	18,105
2872	POTASSIC CHEM FERTILIZER	29,348	0	0	0	29,348
2873	PHOSPHA CHEM FERTILIZERS	1,108	0	0	0	1,108
2911	GASOLINE, INCL NATURAL	0	1,591,908	0	618	1,592,526
2912	JET FUEL	0	523,820	0	0	523,820
2913	KEROSENE	0	19	0	0	19
2914	DISTILLATE FUEL OIL	0	1,695,419	0	5,085	1,700,504
2915	RESIDUAL FUEL OIL	0	3,223,299	0	124,923	3,348,222
2916	LUBRIC OILS-GREASES	0	497,999	0	105	498,104
2917	NAPHTHA, PETRLM SOLVENTS	0	83,803	0	0	83,803
2921	LIQUI PETR-COAL-NATR GAS	92	45,995	0	0	46,087
	Subzone Total :	30,855,268	31,401,610	1,390	133,159	62,391,427

Appendix D ZONE 4 Santa Barbara, CA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 401A				
Passenger	0	60	1,800	1,860
Dry Cargo	3,451	3,451	0	6,902
Tanker	875	438	0	1,313
Dry Cargo Barge Tow	0	0	11	11
Tanker Barge Tow	0	0	172	172

ZONE TOTALS

ZONE 4 Santa Barbara, CA

Vessel Type	Large	Medium	Small	Total
Passenger	0	60	1,800	1,860
Dry Cargo	3,451	3,451	0	6,902
Tanker	875	438	0	1,313
Dry Cargo Barge Tow	0	0	11	11
Tanker Barge Tow	0	0	172	172
Zone Total:	4,326	3,949	1,983	10,258

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix D Zone 4 Santa Barbara, CA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix D Zone 4 Santa Barbara, CA

TABLE 5 Other Local Vessels by Subzone *7/21/91*

Subzone	Name	Number of Vessels	Vessels per Square Mile
401A	Open Area off coast	30,120	12.30
	Total for Zone	30,120	12.30

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 401A				
Passenger	0	63	1,896	1,959
Dry Cargo	4,484	4,700	0	9,184
Tanker	940	468	0	1,408
Dry Cargo Tow	0	0	12	12
Tanker Tow	0	0	192	192
Tug/Tow Boat	0	0	2	2
Subzone Total:	5,424	5,231	2,102	12,757

7/24/91

Appendix D ZONE 4 Santa Barbara, CA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 401A				
Passenger	0	67	1,996	2,063
Dry Cargo	5,384	5,543	0	10,927
Tanker	988	503	0	1,491
Dry Cargo Tow	0	0	13	13
Tanker Tow	0	0	206	206
Tug/Tow Boat	0	0	2	2
Subzone Total:	6,372	6,113	2,217	14,702

Appendix D ZONE 4 Santa Barbara, CA 7/24/91

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 401A				
Passenger	0	69	2,066	2,135
Dry Cargo	6,531	6,590	0	13,121
Tanker	1,042	544	0	1,586
Dry Cargo Tow	0	0	14	14
Tanker Tow	0	0	221	221
Tug/Tow Boat	0	0	2	2
Subzone Total:	7,573	7,203	2,303	17,079

Appendix D ZONE 4 Santa Barbara, CA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 401A				
Passenger	0	71	2,138	2,210
Dry Cargo	8,005	7,919	0	15,924
Tanker	1,104	592	0	1,696
Dry Cargo Tow	0	0	15	15
Tanker Tow	0	0	237	237
Tug/Tow Boat	0	0	2	2
Subzone Total:	9,109	8,582	2,392	20,084

7/25/91

Appendix D ZONE 4 Santa Barbara, CA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	63	1,896	1,959
Dry Cargo	4,037	4,234	0	8,271
Tanker	940	468	0	1,408
Dry Cargo Tow	0	0	12	12
Tanker Tow	0	0	192	192
Tug/Tow Boat	0	0	2	2
1995 Zone Total:	4,977	4,765	2,102	11,844
2000 FORECASTED ZONE TOTALS				
Passenger	0	67	1,996	2,063
Dry Cargo	4,542	4,681	0	9,223
Tanker	988	503	0	1,491
Dry Cargo Tow	0	0	13	13
Tanker Tow	0	0	206	206
Tug/Tow Boat	0	0	2	2
2000 Zone Total:	5,530	5,251	2,217	12,998
2005 FORECASTED ZONE TOTALS				
Passenger	0	69	2,066	2,135
Dry Cargo	5,510	5,378	0	10,888
Tanker	1,042	544	0	1,586
Dry Cargo Tow	0	0	14	14
Tanker Tow	0	0	221	221
Tug/Tow Boat	0	0	2	2
2005 Zone Total:	6,552	5,991	2,303	14,846
2010 FORECASTED ZONE TOTALS				
Passenger	0	71	2,138	2,210
Dry Cargo	6,753	6,462	0	13,215
Tanker	1,104	592	0	1,696
Dry Cargo Tow	0	0	15	15
Tanker Tow	0	0	237	237
Tug/Tow Boat	0	0	2	2
2010 Zone Total:	7,857	7,125	2,392	17,375

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix D Zone 4 Santa Barbara, CA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 401A Open Area off coast						
Passenger	Small	0	0	2	0	2
Dry Cargo	Large	1	0	0	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		2	0	2	0	4
Zone Totals:		2	0	2	0	4

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE D-8 ZONE 4, SANTA BARBARA, CA - VTS LEVELS IN OPERATION

(Not Applicable to this Sub-Zone.)

APPENDIX TABLE D-9 ZONE 4, SANTA BARBARA, CA -
CANDIDATE VTS DESIGN - 1995-2010

UNITS

0	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
3	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
3	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.02	.03
Passenger	Small	.01	.00	.01	.02
Dry Cargo	Large	.38	.08	.69	1.15
Dry Cargo	Medium	.15	.03	.09	.27
Tanker	Large	.15	.04	.30	.49
Tanker	Medium	.01	.00	.01	.02
Dry Cargo Barge T	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
		.71	.15	1.13	1.99

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	34	0	32	66
Passenger	Small	8	1	8	17
Dry Cargo	Large	889	228	278	1,395
Dry Cargo	Medium	368	88	34	490
Tanker	Large	2,683	742	3,479	6,903
Tanker	Medium	27	3	8	38
Dry Cargo Barge T	Small	0	0	0	0
Tanker Barge Tow	Small	81	15	14	110
Tug/Tow Boat	Small	0	0	0	0
		4,089	1,078	3,853	9,020

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.05	.01	.09	.14
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.07	.01	.10	.18
Candidate VTS Design - Dollars					
Passenger	Medium	2,190.78	0.00	3,546.96	5,737.74
Passenger	Small	705.67	122.15	1,054.57	1,882.40
Dry Cargo	Large	71,164.44	14,323.58	130,362.40	215,850.41
Dry Cargo	Medium	28,093.22	5,355.99	16,538.26	49,987.47
Dry Cargo Barge Tow	Small	1.54	.54	.93	3.01
Tanker Barge Tow	Small	27.47	5.56	28.03	61.07
Tug/Tow Boat	Small	.01	.00	.01	.02
Totals		102,183.13	19,807.83	151,531.16	273,522.11

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix D Zone 4 Santa Barbara, CA 7/26/91

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.01	.00	.01	.01
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.01	.00	.02	.03
Candidate VTS Design - Dollars					
Passenger	Medium	37.62	0.00	60.90	98.52
Passenger	Small	1,328.79	230.02	1,985.77	3,544.58
Dry Cargo	Large	1,221.87	245.93	2,238.29	3,706.10
Dry Cargo	Medium	482.35	91.96	283.96	858.27
Dry Cargo Barge Tow	Small	2.68	.94	1.63	5.25
Tanker Barge Tow	Small	48.01	9.72	48.98	106.71
Tug/Tow Boat	Small	.01	.00	.01	.03
Totals		3,121.34	578.58	4,619.54	8,319.46

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.01	.00	.00	.01
Dry Cargo	Large	.28	.05	.07	.40
Dry Cargo	Medium	.11	.02	.01	.14
Tanker	Large	.11	.03	.04	.18
Tanker	Medium	.01	.00	.00	.01
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.53	.11	.13	.77
Candidate VTS Design - Dollars					
Passenger	Medium	7,536.83	0.00	7,085.24	14,622.07
Passenger	Small	2,134.93	288.86	1,767.82	4,191.60
Dry Cargo	Large	206,843.57	39,841.98	40,145.01	286,830.56
Dry Cargo	Medium	98,647.30	17,998.40	3,807.74	120,453.44
Tanker	Large	87,977.15	25,605.63	85,477.87	199,060.65
Tanker	Medium	4,747.76	560.27	2,026.13	7,334.17
Dry Cargo Barge Tow	Small	20.57	4.00	2.00	26.57
Tanker Barge Tow	Small	449.87	50.44	106.58	606.89
Tug/Tow Boat	Small	.03	.01	.03	.06
Totals		408,358.02	84,349.57	140,418.41	633,126.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix D Zone 4 Santa Barbara, CA 7/29/91

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Candidate VTS Design - Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.10	.03	.06	.19
Dry Cargo	Medium	.04	.01	.01	.06
Tanker	Large	.04	.01	.03	.08
Tanker	Medium	.00	.00	.00	.00
Dry Cargo Tow	Small	.00	.00	.00	.00
Tanker Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.19	.05	.10	.34

Candidate VTS Design - Dollars

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	66.31	0.00	44.10	110.42
Passenger	Small	10.80	1.46	7.98	20.24
Dry Cargo	Large	2,129.88	607.36	368.95	3,106.19
Dry Cargo	Medium	840.80	227.11	46.81	1,114.72
Tanker	Large	2,898.26	810.07	4,210.74	7,919.06
Tanker	Medium	61.67	7.23	12.39	81.29
Tanker Tow	Small	93.96	19.03	39.05	152.04
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		6,101.70	1,672.25	4,730.03	12,503.97

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.00	.00	.00
Tanker	Large	0.00	.00	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.00	.00	.00
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.02	.01	.02
Candidate VTS Design - Dollars					
Passenger	Small	0.00	.82	.35	1.18
Dry Cargo	Large	0.00	49.15	22.40	71.55
Dry Cargo	Medium	0.00	18.38	2.84	21.22
Tanker	Large	0.00	26.29	9.78	36.07
Tanker	Medium	0.00	.68	.28	.96
Dry Cargo Barge Tow	Small	0.00	.11	.01	.11
Tanker Barge Tow	Small	0.00	1.09	.27	1.36
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	96.52	35.94	132.46

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix D Zone 4 Santa Barbara, CA 7/26/91

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Candidate VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix D Zone 4 Santa Barbara, CA
TABLE 17 Avoided Hazardous Commodity Spills 199? 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	0.00	.00	.00	.00	.00
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	0.00	.00
JET FUEL	.00	.00	.00	.00	.00
GASOLINE, INCL NATURAL	.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.00	.00	.00	.01
RESIDUAL FUEL OIL	.00	.00	.06	.14	.20
CRUDE PETROLEUM	.00	.01	.00	.00	.01
	.01	.01	.07	.14	.23

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix D   Zone   4 Santa Barbara, CA
TABLE 18A   Annual Benefit & Cost Streams   7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,316	0	0
1996	0	401	443
1997	0	364	405
1998	0	331	371
1999	0	301	340
2000	0	274	311
2001	0	249	286
2002	0	226	263
2003	0	206	241
2004	0	187	222
2005	0	170	204
2006	0	154	188
2007	0	140	173
2008	0	128	159
2009	0	116	147
2010	0	105	135
	5,316	3,351	3,888

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,316	0	0
1996	0	509	562
1997	0	509	567
1998	0	509	571
1999	0	509	575
2000	0	509	579
2001	0	509	585
2002	0	509	591
2003	0	509	597
2004	0	509	604
2005	0	509	611
2006	0	509	619
2007	0	509	627
2008	0	509	636
2009	0	509	644
2010	0	509	653
	5,316	7,633	9,020

APPENDIX D

ZONE 4 - SANTA BARBARA, CA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Santa Barbara Port & Subzone	Species Category	(Port 4) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0401	101	1	American Shad	.9600	.4800	0.0000	0.0000
0401	101	81	Salmon, Chinook	2.7000	1.2000	2.4000	1.2000
0401	101	82	Salmon, Coho	.0130	.0130	.0130	.0130
0401	102	44	Striped Mullet	.0024	.0024	.0024	.0024
0401	102	83	Mackerel, Pacific	.4800	.4800	.4800	.4800
0401	102	84	Mackerel, Jack	3.5800	3.5800	3.5800	3.5800
0401	102	85	Anchovy, Pacific	1.1900	1.1900	1.1900	1.1900
0401	102	86	Herring, Sea	.9500	.9500	.9500	.9500
0401	102	86	Herring, Sea	2.2000	0.0000	2.2000	4.5000
0401	103	9	Monkfish	.5800	.5800	.5800	.5800
0401	103	50	Bonito	.0750	.1500	.0750	0.0000
0401	104	12	Tuna	0.0000	.2200	0.0000	0.0000
0401	104	13	Swordfish	.0480	.0480	.0480	.0480
0401	104	14	Shark	.0590	.0590	.0590	.0590
0401	104	14	Shark	1.7000	1.7000	1.7000	1.7000
0401	104	15	Dogfish	.0010	.0010	.0010	.0010
0401	105	87	Right-eye Flounder	4.1936	4.1936	4.1936	4.1936
0401	105	104	Flounder, Starry	1.8000	1.8000	1.8000	1.8000
0401	105	113	Left-eye Flounder	39.3581	39.3581	39.3581	39.3581
0401	106	36	Drum	52.6790	52.6790	52.6790	52.6790
0401	106	90	Rockfish	2.3243	2.3243	2.3243	2.3243
0401	106	92	Sablefish	2.8000	2.8000	2.8000	2.8000
0401	106	94	Lingcod	.2800	.2800	.2800	.2800
0401	106	95	Hake, Pacific	0.0000	0.0000	0.0000	10.7000
0401	106	96	Sea Bass	.0796	.0796	.0796	.0796
0401	106	109	Sculpin	.0159	.0159	.0159	.0159
0401	106	111	Poacher	.0011	.0011	.0011	.0011
0401	106	120	Goby	.0286	.0286	.0286	.0286
0401	106	142	Killyfish	.3559	.3559	.3559	.3559
0401	106	143	Surf Perch	7.6737	7.6737	7.6737	7.6737
0401	107	208	Blue Mussel	1.8000	1.8000	1.8000	1.8000
0401	107	211	Soft Clam	.4700	.4700	.4700	.4700
0401	107	220	Abalone	.8125	.8125	.8125	.8125
0401	108	217	Crab	.0850	.0850	.0850	.0850
0401	108	219	Lobster, Spiny	.0300	.0300	.0300	.0300
0401	108	221	Crab, Dungeness	.3200	.3200	.3200	.3200
0401	108	222	Shrimp, Pacific	2.4000	2.4000	2.4000	2.4000
0401	109	223	Squid, Pacific	.4800	.4800	.4800	.4800

APPENDIX D

ZONE 4 - SANTA BARBARA, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Santa Barbara		(Port 4)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0401	202	1084	Mackerel, Jack	.0100	0.0000	0.0000	0.0000
0401	202	1085	Northern Anchovy	10.0000	5.0000	10.0000	50.0000
0401	202	1119	Sardine	.5000	0.0000	0.0000	0.0000
0401	205		Other Larvae	54.5000	32.7000	17.8000	.2000
0401	205	1087	Slender Sole	.5000	0.0000	0.0000	0.0000
0401	205	1088	Halibut	.5000	0.0000	0.0000	5.0000
0401	205	1113	Speckled Sand Dab	0.0000	0.0000	.5000	.5000
0401	206		Other Larvae	.2700	4.6000	10.1000	.2000
0401	206	1090	Rockfish	5.5000	5.5000	50.0000	50.0000
0401	206	1095	Hake	3.0000	0.0000	0.0000	0.0000
0401	206	1101	Turbot	0.0000	.5000	0.0000	.5000
0401	206	1107	English Sole	0.0000	0.0000	0.0000	5.0000
0401	206	1199	Other Larvae	16.5500	16.5500	16.5500	16.5500
0401	207		Other Larvae	.0095	.0950	.0095	0.0000
0401	208		Other Larvae	.1600	.4200	0.0000	0.0000

APPENDIX D

ZONE 4 - SANTA BARBARA, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Santa Barbara		(Port 4)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0401	111	512	Coot	1.2751	0.0000	1.2747	2.5108
0401	111	513	Goose	6.9530	0.0000	6.9530	13.9061
0401	111	514	Swan	.6567	0.0000	.6567	1.2747
0401	111	515	Duck	44.4222	0.0000	44.4222	88.8444
0401	111	515	Waterfowl	1.6463	1.6463	2.0631	2.0631
0401	112	561	Water-Associated Species	.0127	.0127	.0205	.0205
0401	112	571	Shore Birds	5.5524	5.5524	3.0338	3.0338
0401	112	599	Other	.0019	.0019	.0842	.0842
0401	113	530	Cormorant, Pelican	1.9638	1.9638	1.8480	1.8480
0401	113	531	Gull, Tern	16.6332	16.6332	19.3546	19.3546
0401	113	534	Pelagic Species	14.7798	14.7798	.1221	.1221

APPENDIX E

PORT ARTHUR, TX

(ZONE 5)

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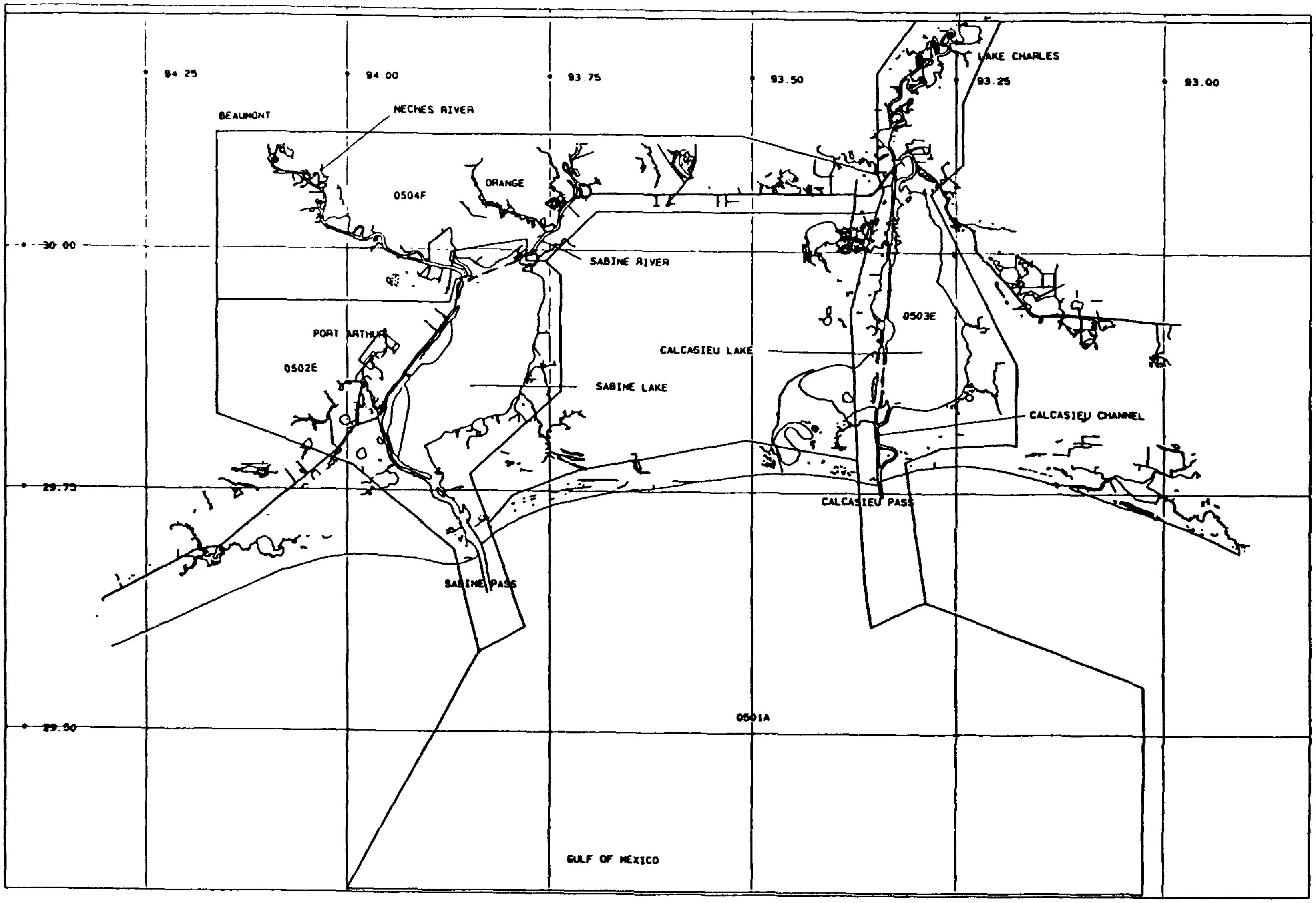
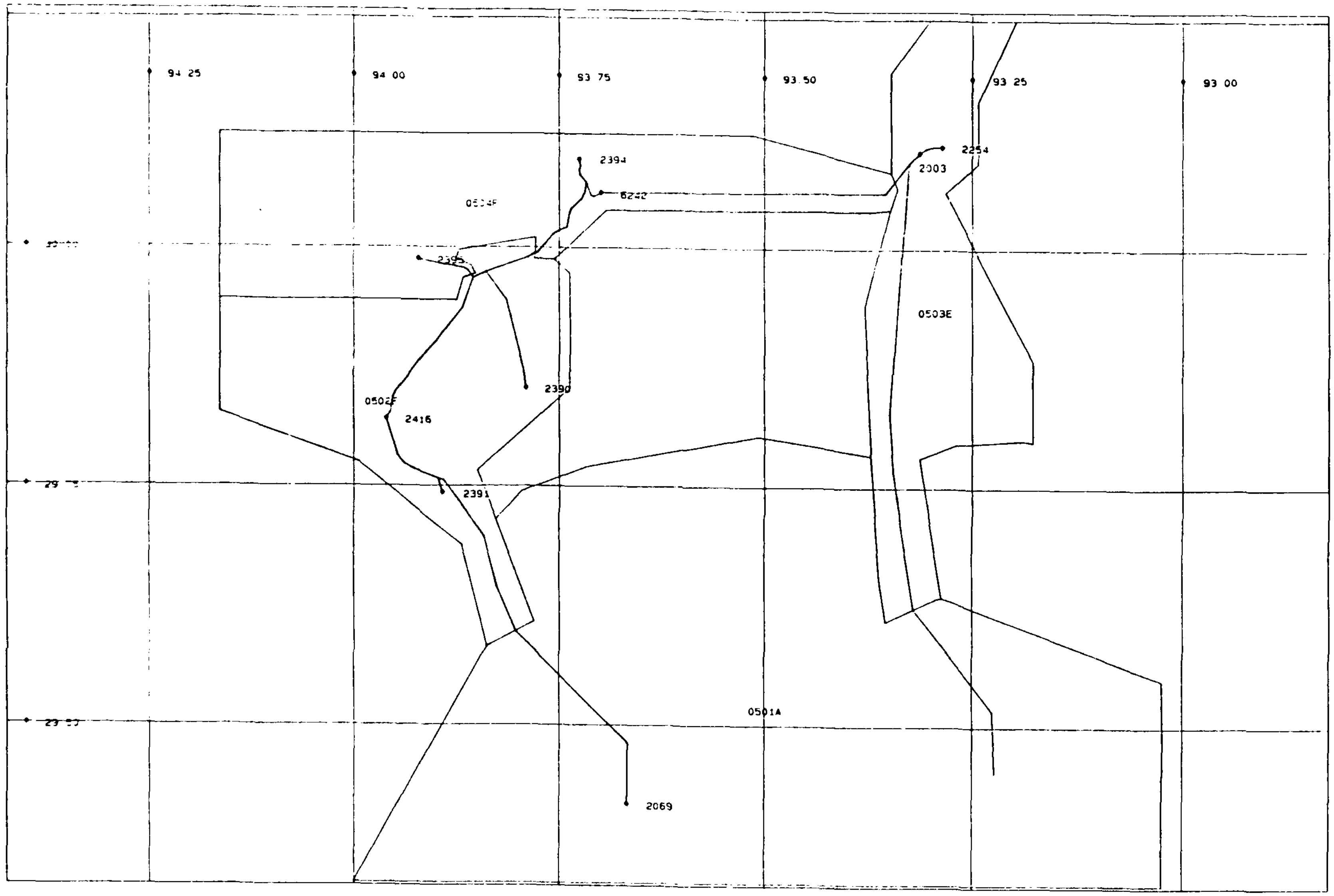
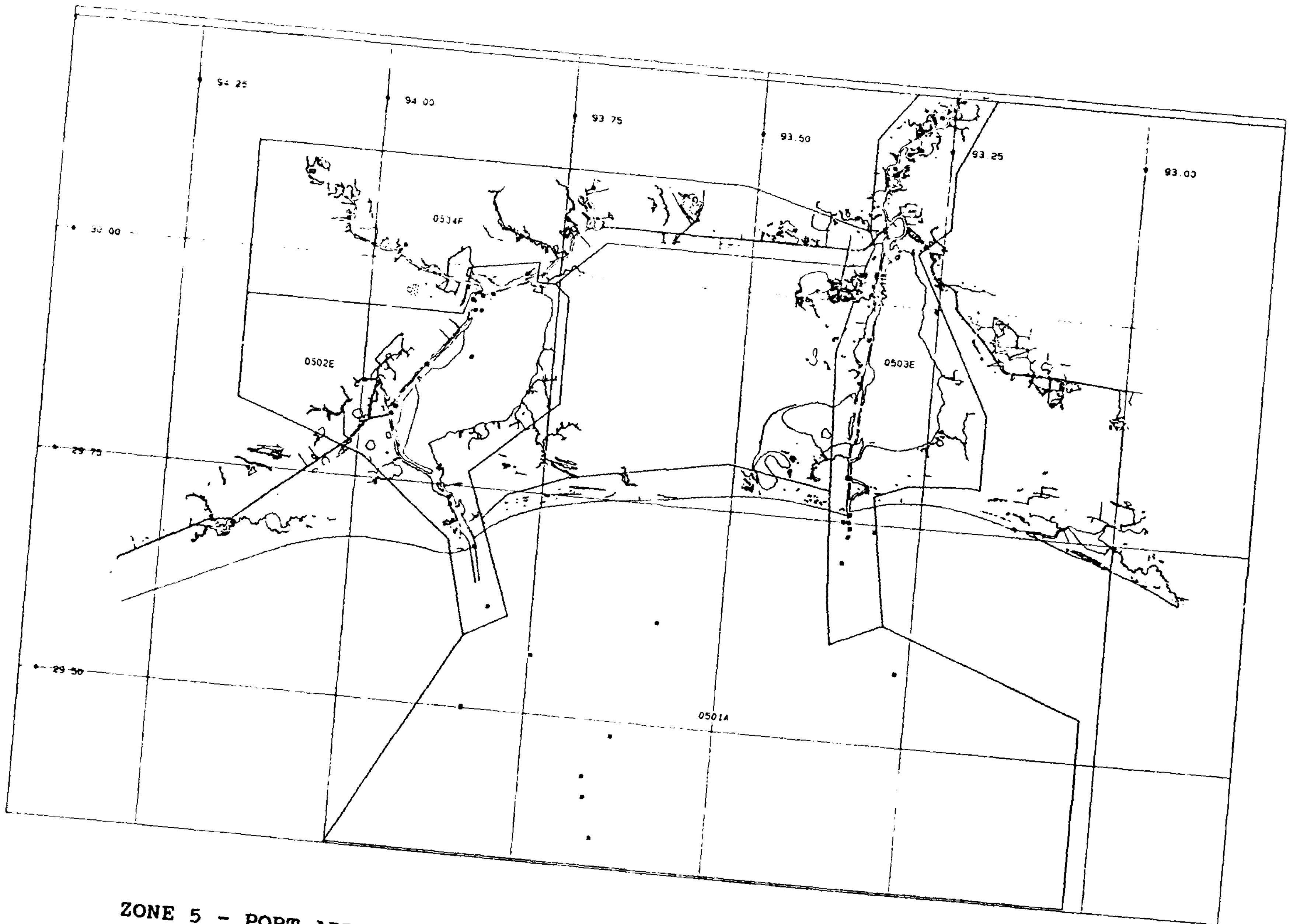
STUDY ZONE MAPS



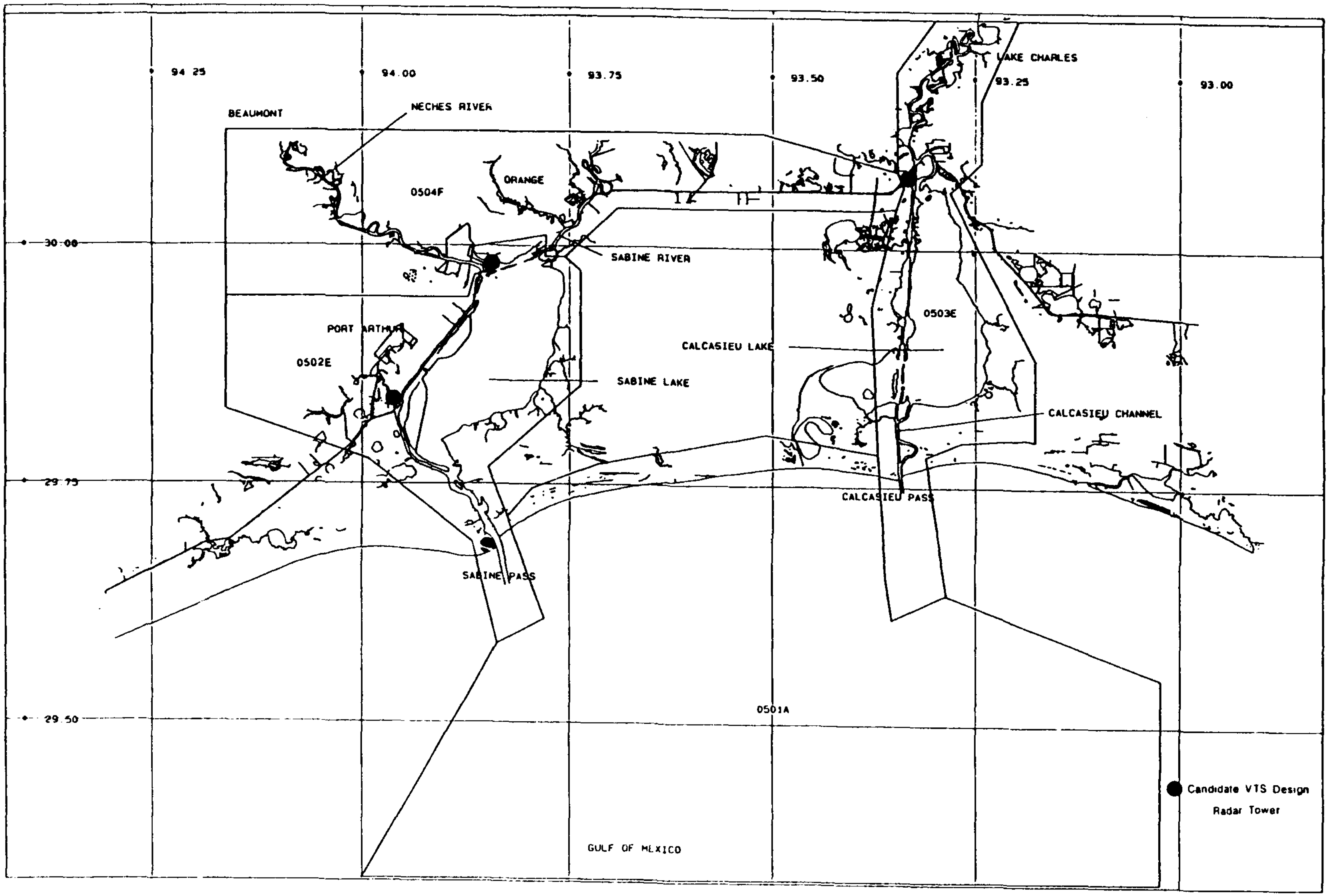
ZONE 5 - PORT ARTHUR, TX - ZONE AND SUBZONE BOUNDARIES



ZONE 5 - PORT ARTHUR, TX - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 5 - PORT ARTHUR, TX - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 5 - PORT ARTHUR, TX - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PORT ARTHUR, TX

(ZONE 5)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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1.0 SCOPE

This report includes a port survey and a VTS design for Port Arthur,Tx./Lake Charles,La. The port survey is based on a visit to Port Arthur, a physical inspection of its problem areas, extensive interviews with key personnel, and a review of all pertinent literature including navigation charts for both ports. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT ARTHUR SURVEY

2.1 INTRODUCTION

The Port Arthur study area includes the extensive system of deepwater routes which lie inside Sabine Pass, and in addition to Port Arthur itself also addresses the Ports of Orange and Beaumont. This "Golden Triangle", as it is colloquially known, contains extensive refineries, petro-chemical plants and storage facilities for both refined petroleum products and hazardous chemicals. Deep-draft traffic is not extensive, ranging from five to eight movements per day, but is almost exclusively devoted to petroleum and chemicals, including LNG. During a portion of their passage these deep-draft carriers intermingle and compete for waterway space with Intracoastal Waterway (ICW) shoal draft-traffic. The number of shoal-draft movements is not precisely known, but the stretch of ICW is part of the New Orleans-Houston/Galveston route touted by an earlier USCG study as the busiest waterway in the United States.

The statistical likelihood of marine incidents involving two or more vessels is very small. While the **probability** of such an occurrence may be slight the **possibility** exists, and because of the materials carried the results of an incident should one occur could be catastrophic.

2.2 OVERVIEW OF THE PORT

The waterway within the Study area basically consists of improved natural channels augmented and connected by artificially created canals. In consequence, the waterways within the complex are narrow, requiring careful management of inbound and outbound traffic movement in order to avoid hazardous meetings. In addition to narrowness, the channels have a limiting depth of

40'. Given the size of ships calling at ports within the study area, pilots pay careful attention to timing movements with the tides and wind conditions playing an important part in the decision-making process. One saving grace is that the bottom is soft and vessels of all types can normally take the ground without consequence.

The tidal range averages 2.5', but is highly dependent upon wind direction and velocity. Wind can make a difference of up to 4' in tidal range. Tidal current velocities can exceed 2.5 knots between the Sabine Pass jetties.

The Port area is approached from the Gulf of Mexico through a series of Safety Fairways established to reduce conflicts between offshore oil production/development and shipping. The final stages of the approach is through a channel restricted by spoil and dumping grounds to either hand. The approach can be difficult during periods of poor visibility because of the featureless nature of the low-lying land.

One difficult characteristic of the waterway is the near-total absence of suitable anchorages, lay-berths and passing areas. The effect upon traffic management is to require that ships entering the system have a specific berth open to them before they enter, introducing a queuing problem currently resolved by the pilots. The absence of lay-berths is primarily of economic rather than management importance. The area's one Federal Anchorage is currently not available to shipping because it is used as a "parking lot" for retired oil rigs.

Between Texaco Island (Approx. 29 degrees-50' and Orange, the deep-water channel is shared with ICW traffic. Tows of sufficient size use the ICW making interaction with deep-draft shipping (meeting, overtaking, and crossing) difficult, particularly at bends.

The waterway is host to numerous fishing and recreational craft.

2.3 EXISTING TRAFFIC MANAGEMENT

A Regulated Navigation Area has been established in the "Sabine Neches Waterway", a system which includes Sabine Pass Channel, Port Arthur Canal, Neches River, Sabine River and all navigable waterways tributary thereto, by 33CFR165.806. The regulations established for the Area deal exclusively with the safety and maneuverability of tows.

Pilotage is compulsory for all foreign-flag vessels and U. S. ships under registry in the foreign trade. Pilotage is optional for U. S.-flag ships in coastwise trade that have on board a Federally licensed pilot. Pilot service is provided by the Sabine pilots.

The Sabine Pilots, in consultation with waterway users and the U.S. Coast Guard (USCG) Captain of the Port (COTP), Port Arthur, have established formal guidelines for the Sabine-Neches Waterway. Published in the Coast Pilot (Reference 1), the guidelines make public the basic framework used by the pilots in furnishing a coordination service to traffic in the Sabine Bank Channel, Sabine Pass, Port Arthur Canal, Sabine-Neches Canal and Neches River. The guidelines consist of a series of rules of thumb regarding vessel size, meeting situations, one-way traffic and the like. One criticism, voiced during interview sessions, is that ICW traffic needs were insufficiently considered when developing the Guidelines and have not been incorporated therein.

Through use of the Guidelines large vessel traffic into Port Arthur is managed by the Sabine pilots, with no management exerted over ICW traffic. CH13 Bridge-to-Bridge radiotelephone is used extensively to resolve meeting and passing situations. Deep-draft traffic in the narrow Sabine-Neches Canal is "one-way" and controlled by the pilots. CH13 is not monitored by the USCG although it does have CH13 capability with a local transceiver. The pilots do not have high level CH13 capability and do not monitor this channel at the pilot station. Nighttime transits of large vessels (tankers) is not permitted and the queue resulting from the limited capacity of the Port Arthur waterways is completely controlled by the pilots. Barge traffic proceeds independent of pilot-managed operations and there are conflicts between the two different modes. Additionally, other commercial and private traffic going through the Intracoastal Waterway (ICW), which intersects and becomes part of the Sabine-Neches Canal, causes conflicts. Insufficient information about other types of traffic within the waterway system is one of the basic causes of these conflicts. Misuse of CH13, particularly by Vietnamese-manned fishing vessels, is reported. The lack of suitable anchorages, lay-berths and passing areas along with the narrow channel is a major reason for the limited capacity of the Port Arthur waterways.

2.4 VESSEL TRAFFIC

Deep-draft shipping volume consists of 5-8 moves per day, with no reliable figures available about the volume of ICW traffic moving through the Study area, or between ports/facilities in it. The preponderance of deep-draft movements involve the carriage of petro-chemicals and hazardous material, with the largest ships, in terms of bulk, being LNG carriers. In addition to petrochemicals and hazardous materials, there is significant bulk trade in grain, potash and petroleum coke. The nature of goods carried in the ICW is more varied, with reliable data not available about percentages of petro-chemicals and hazardous materials.

Commercial small craft activity, fishing and offshore support craft, tends to be concentrated at or near Sabine Pass itself, and conflicts - other than in radio use - rarely occur.

2.5 ENVIRONMENTAL SENSITIVITY

The Port Arthur Study area is in the middle of a sensitive tidal marsh-wetlands area with important fisheries implications. The wetlands also feature important feeding grounds for migrating aquatic birds.

The most sensitive environmental consideration, however, stems from the movement of large quantities of hazardous materials through channels which are in close proximity to population centers. The "worse case" scenario is the collision resulting in toxic gas release at Port Arthur proper. Such a release, occurring during a period with an easterly wind could result in a large number of human casualties.

There are two oil spill "worse cases". Both are based upon a collision involving a tank ship or barge, and the subsequent release of a large volume of oil. One occurs near Humble Island where, coupled with a NW wind and an ebb tide, the spill inundates the marshes and tidal wetlands of the Lake Sabine area. The second is postulated at or just above Texaco Island.

2.6 PORT SUB-ZONES

The harbor was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 2).

Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

2.6.1 Sub-Zone I -- Port Arthur Approaches (NOAA Chart 11341)

This sub-zone lies seaward of a line between Sabine Bank Channel Lighted Buoys #1 and #2.

The sub-zone, with its associated Fairway Anchorages, is critical to the queuing of inbound traffic. The approach is through a Safety Fairway and the Coast Pilot recommends that the entrance not be approached until a pilot is on board. For these reasons the sub-zone is classified as "confined-complex."

2.6.2 Sub-Zone II -- Sabine Bank Channel (NOAA Chart 11341)

This sub- .one lies between a line between Sabine Bank Channel Lighted Buoys #1 and #2 and the COLREGS Demarcation Line as established by 33CFR80.840a.

This sub-zone consists largely of the Federal Project channel maintained to 40'. Some shoaling and the presence of obstructions has been reported and local knowledge is critical to deep-draft passage. The area to either hand is foul ground, because of the presence of numerous oil platforms and spoil dumping areas. The Inshore Safety Fairway crosses the Sabine Bank Channel at right angles and shallow-draft traffic enters and leaves Sabine Pass outside of the marked channel.

Entry into the channel commits deep-draft ships to complete the transit to the receiving facility. Vessel interaction within the channel is largely limited to overtakings and meetings. This sub-zone is classified as "confined-complex."

2.6.3 Sub-Zone III -- Port Arthur Canal (NOAA Chart 11341)

This sub-zone lies between the COLREGS Demarcation Line established by 33CFR80.840a and a line drawn normal to the axis of the channel at Port Arthur Canal Light #47.

This sub-zone consists of a relatively straight channel within which little opportunity exists for other than meeting and passing situations. It is classified as "confined-simple".

2.6.4 Sub-Zone IV - Sabine-Neches Canal (NOAA Chart 11342)

This sub-zone is bounded by a line drawn normal to the channel axis at Port Arthur Canal Light #47, a line across the Intracoastal Waterway (ICW) east of its juncture with the Taylor Bayou Outfall Canal, a line across the Sabine-Neches Canal at Sabine-Neches Canal Buoys #71 and #72, and a line normal to the axis of the Neches River 2.1 miles west of Humble Island Light "R".This sub-zone includes several channel confluences and is shared by deep-water and ICW traffic. Some key facilities exist within the sub-zone, introducing maneuvering vessels making and leaving berths. Much of the shared channel runs in proximity to population centers to the west and sensitive wetlands to the east. The sub-zone is classified as "confined-complex."

2.6.5 Sub-Zone V -- Port of Beaumont (NOAA Chart 11343)

This sub-zone is bounded by a line drawn normal to the axis of the Neches River at a point 2.1 miles west of Humble Island Light "R" and the Head of Navigation at Beaumont.

This sub-zone is shared by deep-water and ICW traffic. Key facilities exist within the sub-zone, introducing maneuvering vessels making and leaving berths. Much of the shared channel runs in proximity to population centers to the west and sensitive wetlands to the east. The sub-zone is classified as "confined-complex".

2.6.6 Sub-Zone VI -- Port of Orange (NOAA Chart 11343)

This sub-zone is bounded by a line normal to the axis of the Sabine-Neches Canal at Sabine-Neches Canal Buoys #71 and #72, the Head of Navigation at Orange and a line normal to the axis of the ICW at 93-41.7 West Longitude.

This sub-zone is shared by deep-water and ICW traffic. Key facilities exist within the sub-zone, introducing maneuvering vessels making and leaving berths. Much of the shared channel runs in proximity to population centers to the west and sensitive wetlands to the east. The sub-zone is classified as "confined-complex".

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

2.7.1 PAI II-1. Sabine Bank Channel

The Sabine Bank Channel raises two traffic management issues. First, the intersection of the channel to Port Arthur and the coastwise safety fairway offers the potential of crossing situations developing between ships whose maneuverability is channel-limited. Second, the Sabine Bank Channel and its associated Fairway Anchorage represents the "last" opportunity to accomplish the queuing of inbound ships necessary to prevent traffic conflicts in the narrow inner channels.

2.7.2 PAI III-1. Sabine Pass Federal Anchorage

The Sabine Pass Federal Anchorage is the only such area in the port complex. Careful management may be required as part of the overall management of traffic flow since it represents one alternative to prevention of hazardous meetings in the narrow channels to the north.

TABLE 2-1. PORT ARTHUR PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM/POTENTIAL PROBLEM	MANAGEMENT REQUIREMENT
II-1	Sabine Bank Channel	Regulation and queuing of inbound shipping is necessary to minimize potential problems in narrow inside channels. There is also the potential for cross-traffic at the intersection of two Safety Fairways.	Knowledge of ship movements Traffic advisory communications Up-to-date weather, tidal and current information
III-1	Sabine Pass Federal Anchorage	Only Federal anchorage in port complex, with few other choices available as anchorage area or lay-berths. Careful management is required as part of the overall approach to managing the traffic stream and to avoid hazardous meetings.	Knowledge of ship movements Locations of ships in anchorages and knowledge of anchorage activities Traffic advisory communications Up-to-date weather, tidal and current information
IV-1	Intersection of ICW and Port Arthur Canal	Potential conflict between ICW traffic and deep-draft shipping constrained by draft.	Knowledge of ship movements Traffic advisory communications Up-to-date weather, tidal and current information
IV-2	Intersection, Neches River and Sabine-Neches Canal	Conflict between ICW traffic and deep-draft shipping constrained by draft	Knowledge of ship movements Traffic advisory communications Up-to-date weather, tidal and current information
VI-1	Intersection of ICW and Sabine River	Conflict between ICS traffic and deep-draft shipping constrained by draft	Knowledge of ship movements Traffic advisory communications Up-to-date weather, tidal and current information

2.7.3 PAI IV-1. Intersection of the Intracoastal Waterway (ICW) and the Port Arthur Canal

The intersection represents a point of congestion where the traffic stream to and from sea, normally deep-draft and constrained by draft, meets and mixes with the tow & barge traffic of the ICW.

2.7.4 PAI IV-2. Intersection of the Neches River and Sabine-Neches Canal

The intersection represents a point of congestion where the traffic stream to and from sea, normally deep-draft and constrained by draft, meets and mixes with the tow & barge traffic of the ICW.

2.7.5 PAI VI-1. Intersection of the ICW and the Sabine River

The intersection represents a point of congestion where the traffic stream to and from sea, normally deep-draft and constrained by draft, meets and mixes with the tow & barge traffic of the ICW.

3.0 LAKE CHARLES PORT SURVEY

3.1 INTRODUCTION

The Port of Lake Charles as addressed by this Study includes the Lake Charles-Calcasieu River-Calcasieu Lake waterway complex from its Gulf offshore approaches to the head of deep-draft navigation at the Interstate 10 fixed bridge at the north end of Lake Charles. Although there is some commercial traffic serving port facilities located north of the bridge the volume and potential for traffic management problems is small enough to exclude that area from consideration.

The city of Lake Charles, near which many of the significant port facilities are located, lies inland some 25 miles from the Gulf of Mexico and is approximately halfway between the Mississippi River and Galveston Bay. It is served by deep-draft shipping reaching the port through a Federally maintained channel that improves the natural Calcasieu River-Calcasieu Lake route, and by barges via the Intracoastal Waterway (ICW). ICW and deep-draft traffic share the same waterway within one area of the port. The deep-water channels are narrow, draft-limiting and require one-way traffic for large ships.

About 60% of the deep-draft cargo consists of petroleum products and chemicals. This volume, when coupled with movement of 5-8 LNG carriers per month, provides high potential for a polluting spill or hazardous material release incident to marine casualties. In addition, although reliable statistics are not

available, hazardous and/or pollutant cargoes are carried by a significant percentage of the ICW barges. This is a major factor affecting risk determinations, particularly considering that the New Orleans-Houston/Galveston section of the ICW is the busiest waterway in the United States.

In addition to cargo movement, the port supports significant offshore industry and fisheries activities. These are largely centered around Monkey Island, near the port entrance, and at the town of Cameron which lies along a back channel created by Monkey Island.

3.2 OVERVIEW OF THE PORT

Climate is characterized as humid and subtropical. The land from the city of Lake Charles to the coast is low, and is dominated by marshes, bayous, and lakes. Visibility, particularly at the port's seaward entrance, reduces to less than a quarter mile during about 50 days per year (Reference 3), primarily between October and March. The diurnal tidal range is about two feet at Calcasieu Pass, with little current in the waterways inshore of the jetties except during freshets. Weather conditions can modify normal tidal ranges by several feet. The bottoms of the channels throughout the port are "soft", with a layer of vegetative sludge forming the boundary between firm bottom and water. This condition makes it possible for ships to ground without structural damage, allowing movement which might otherwise be impossible and permitting grounding to be used as a collision-avoidance measure.

The approach to the port from seaward is through a series of Safety Fairways designed to insure unobstructed passage of deep-draft shipping through the profusion of offshore activity present throughout Gulf inshore waters. Approach navigation is facilitated by Loran-C coverage providing good crossing angles, an aid of particular importance when making landfall upon a low-lying, unrelieved coastline in reduced visibility. (The sea buoy, Calcasieu Channel Lighted Whistle Buoy "CC", is, at nearly 27 miles offshore, well out of sight of land even under conditions of excellent visibility.)

The Calcasieu Entrance has been improved by a Federal project which carries 42' depth from the outer bar to that depth in the Gulf and is well marked by buoyage. From the outer bar inward channel depths are as tabulated on the most recent charts and are generally 40'to a point above Choupique Island, where depths reduce to 35'. A lighted range marks center channel throughout the jetty leg of Calcasieu Pass. The entrance presents a series of hazards to deep-draft navigation. A strong westerly current normally sweeps across the channel just seaward of the jetties, but strong westerly winds can cause current reversals. A series of spoil banks of uncertain coverage line the west side of the entrance and outer channels and several submerged obstructions

have been reported in the Fairways and Fairway anchorages. Although examination of the appropriate charts will reveal spoil bank(s) east of the channel, these are not included in the Coast Pilot's list of "Dangers".

Pilotage is compulsory for all foreign-flag vessels and U. S. ships under registry in foreign trade. Pilotage is optional for U. S.-flag ships of over 100 tons in coastwise trade that have on board a Federally licensed pilot. Pilotage is provided by the Lake Charles pilots, who maintain a pilot station on Monkey Island. The pilot station monitors VHF-FM Channels 12, 16 and 66A, and uses CH66A as the pilot working frequency. Guard is also maintained on 4419.4 Khz HF Single-Sideband. The pilot station functions as the Vessel Traffic Center (VTC) for Lake Charles VTS. (See Paragraph 3.3.2.) Three pilot boarding stations lie seaward of Calcasieu Channel Lighted Buoy 38, with selection of the boarding station used a function of ship draft.

Inside the entrance, the deep-draft channels from the Jetty Channel to Lake Charles itself are maintained to a width of only 400 feet. In effect, this constrains large ship traffic to a "one-way" pattern, to avoid meeting situations. (Between the entrance and the various berths there are no anchorages or lay-berths to accommodate meetings and overtakings.) The channel is well marked throughout by a combination of buoys, fixed aids and mid-channel ranges.

Offshore support and fishing vessels share the channel with deep-draft ships to approximately Calcasieu Channel Light 53, above which the volume of minor traffic falls off dramatically. In addition to the offshore and fishing activities centered about the Cameron Loop, an auto ferry crosses the main channel just north of Calcasieu Channel Light 53. Between Light 53 and the Choupique Cutoff, where the ICW joins the Calcasieu River channel from the west, deep-draft shipping encounters smaller vessels only occasionally.

The deep-draft traffic pattern splits at the Choupique Cutoff. Ships bound to facilities at Lake Charles continue along the improved Calcasieu River channel while those servicing facilities on the Lake Charles Industrial Canal join with the ICW flow for the one mile stretch across the northwestern side of Choupique Island. (Although not identified as such on NOAA Chart 11347, the Industrial Canal is identified as that portion of the waterway which extends as a cul de sac generally eastward from the channel bounding the north side of Choupique Island). The combined flow separates again at the "Devil's Elbow" (north end, Choupique Island), with the deep-draft traffic flow entering the eastern portion of the Industrial Canal and the ICW traffic shaping for the Calcasieu Lock. The patterns for westbound ICW/outbound deep-draft are, of course, reversed. The area thus

described represents the highest risk area within the port complex for several reasons:

- o Inward shipping bound for a facility in the Industrial Canal must alter course 42 degrees to conform to the reach across the top of Choupique Island. In the process, that shipping must join the eastbound ICW traffic stream and can meet westbound ICW shipping. Such meetings could be rendered disastrous by a wide turn which takes the deep-draft ship left of the channel centerline and, at best, a ship of 120' beam meeting a wide tow will leave small margin for error. At the Devil's Elbow the ship must alter course to the left to enter the Industrial Canal, crossing the westbound ICW flow. The crossing point coincides with the location at which ICW traffic must negotiate a 120 degree turn.

- o The LNG terminal is at the NE end of the Industrial Canal and, while the moving Safety Zone protects the LNG carrier, LNG movement suspends ICW movement whenever a non-gasfree carrier is moving in the vicinity of Choupique Island.

- o Outbound shipping from Industrial Canal facilities must first join the westbound ICW flow and then turn left across eastbound ICW traffic.
- o Inbound and outbound shipping serving Lake Charles facilities must pass through both east and west ICW traffic flows.

Deep-draft ships in the river north of Choupique Cutoff share the waterway with tows and other traffic, although the number of encounters are not large.

Basic traffic management requirements, considering only deep-draft ships, are quite simple. Adequate advance notice of movements coupled with regulation of departures, entrances and queuing would suffice to virtually eliminate multi-ship incidents. This simplicity is upset by two factors:

- o Since offshore support and fishing activities are concentrated at Monkey Island and Cameron there is the potential for interaction between craft serving those industries and deep-draft shipping anywhere in the channel between the seaward entrance to the Jetty Channel and Calcasieu Channel Light 53. A collision resulting from such interaction could give rise to a spill, a hazardous material release, a channel blockage, or all three.

- o The conditions around Choupique Island, as described.

3.3 EXISTING TRAFFIC MANAGEMENT

Traffic management within the port area has received considerable attention, probably as the result of the hazardous nature of much of the cargo moved by deep-draft ships and the narrowness of the waterways, and addresses the difficulties identified above.

3.3.1 Management Problems

Several problems complicate traffic management, but these are not unique to the Lake Charles area. Many mariners report improper use of Channel 13 through excessive transmitter power and using the channel for traffic not related to the safety of navigation. It should be noted that neither the Coast Guard nor the pilots' monitor Channel 13. Other than communications, most of the remaining problems seem to focus upon conflict between the different users; most notably failure of small craft to yield to deep-draft ships constrained by the channel and between ships and tugs/tows using the ICW. Concern has been expressed by towboat operators that while the traffic management measures in effect are appropriate for deep-draft shipping they take too little account of ICW tug/tow needs and constraints. The tug/tow concerns focus upon pilothouse workload and communications requirements. The tugs normally operate using a single person in the pilothouse. In addition to piloting the tug and tow the pilothouse watch must also handle communications and perform some internal functions. As a result, watchstanders reportedly becomes saturated. This in turn frequently results in failure to guard or to transmit required security broadcasts on Channel 13.

These problems are of significance to system design. The most obvious impact is to impose surveillance requirements where they would otherwise not exist in order to cover information gaps created by poor communications capability.

Deep-water users and pilots alike have expressed the opinion that overall safety improvements require better enforcement of the existing procedures, widening of the channels and the provision of lay-berths before considering changes to the existing VTS.

3.3.2 Vessel Traffic Service (VTS)

A Vessel Traffic Service operated by the Lake Charles pilots has been established for the Port of Lake Charles and the Calcasieu Ship Channel (between Calcasieu Channel Lighted Whistle Buoy CC and the Interstate Route 10 Bridge at Lake Charles). This voluntary VTS seeks to provide ships with a surprise free scenario and prevent meetings and overtakings in constrained channels.

It should be noted that rules governing VTS Lake Charles **have not** been promulgated as Regulations in 33CFR161 and there are ambiguities in the procedures published in the Coast Pilot (Reference 3). By implication, only shipping requiring or carrying a Lake Charles pilot are regularly included in the system. This means that the number of "non-participants" are undoubtedly significant and that a "surprise free scenario" cannot with certainty be achieved with the present system.

VTS Lake Charles uses VHF-FM Channels 66 and 66A as its working frequencies and the service consists of a series of reporting requirements, initiated by notifying the VTS at least two hours in advance of entering the system inbound or, if moored within the system area, two hours in advance of intended movement. Additional reporting requirements permit the VTS to keep track of vessel locations within the system and to provide all concerned with relevant information. VTS Lake Charles also guards VHF-FM Channels 12 and 16.
A series of "Special Conditions" exist within the VTS area. These include, among other things that:

- o Vessels which draw over 32 may not meet other traffic if the combined beams of the meeting ships will exceed 50% of the channel width.
- o The queue of ships waiting to move is ordered based upon time of entry into the system.
- o Rule 1 above notwithstanding, meetings will be permitted only with the concurrence of the masters and pilots involved.

3.3.3 Calcasieu River Navigation Guidelines

The COTP has developed a series of "guidelines" applicable to vessels proceeding between the sea and the Port of Lake Charles which, while not mandatory, are "recommended". The "guidelines" are published in the Coast Pilot (Reference 3) and include procedures for low-powered, full-powered and poor-handling vessels (including tows), recommend security broadcasts on Channel 13 by all inbound traffic 30 minutes before entering the Calcasieu River jetties and by ICW traffic before crossing the Calcasieu River, and identify two "Areas of Particular Concern". These are:

- o Monkey Island, because of high usage by offshore industry and fishing craft. Vessels transiting the area should exercise particular care to avoid causing wake damage.

o Intracoastal Waterway (ICW), at the point where the ICW crosses the main ship channel. Special steps are needed to minimize conflict between user types.

3.3.4 Regulated Navigation Areas

A "Regulated Navigation Area" has been established by 33CFR165.1 through 33CFR165.13 and 33CFR165.807 governing the Calcasieu River from the seaward entrance to the Port of Lake Charles. The regulations thus imposed govern hawser tows of 1000 gross tons or greater, as well as the shifting of tows in the vicinity of the entrance jetties.

A permanent Safety Zone has been established in the Calcasieu Channel and Industrial Canal to protect ships moored at the Trunkline LNG Terminal. Moving Safety Zones are imposed around moving non-gasfree LNG ships. Meetings, crossings and overtakings are not permitted within moving Safety Zones without the specific authorization of the COTP. (See 33CFR165.805). LNG carrier movement is restricted to daylight hours only.

3.4 VESSEL TRAFFIC

Ship traffic carries a mix of cargoes, with distribution by tonnage approximately 40% crude oil, 20% chemicals and 40% mixed break-bulk, bulk and ro-ro. Clearly, the preponderance of deep-draft movements involve the carriage of petro-chemicals and hazardous material, with the largest ships, in terms of bulk, being LNG carriers. In addition to petro-chemicals and hazardous materials, there is significant bulk trade in grain, cement and forest products. The nature of goods moving within the port complex via the ICW is more varied, with reliable data not available about percentages of petro-chemicals and hazardous materials. (Discussions with towboat operators, however, indicated that a significant percentage of the tows carry at least some hazardous materials.)

Good movement statistics exist for deep-draft ships, with the reported average about 900 per year. LNG traffic is in the process of resuming, after a five year shut-down. Initially, five calls by LNG carriers per month are anticipated with the expectation that this figure will grow to eight per month.

3.5 ENVIRONMENTAL SENSITIVITY

The entire waterlogged area surrounding the port complex supports a variety of aquatic fowl, fish and mammals. The areas on the west and south sides of Calcasieu Lake are part of the Sabine National Wildlife Refuge. The usual marshland ecological fragility applies, and it is clear that a pollution incident occurring inside the jetties could harm a large-sized area. The "worse-case" pollution scenario would envision a major spill of crude

oil at either end of Calcasieu Lake, coupled by a wind which would spread the pollutant across the entire lake shoreline.

Pollution incidents inside the jetty should be, with some notable exceptions, amenable to containment because of the narrowness of the waterway and the general absence of current. One economic consequence might well be suspension of river and ICW traffic while cleanup operations are in progress.

The "most-likely" scenario is an incident between a ship and tow, or between two tows, in the area north of Choupique Island. The greatest threat resulting from the "most-likely" incident is the release of hazardous material, particularly as vapor into the atmosphere. An incident resulting in a prolonged closure of the ICW would probably have the greatest economic impact.

Hazards represented by LNG movement are minimized by adherence to the COTP's LPG/LNG Operations Plan.

3.6 PORT SUB-ZONES

The port was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 2). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs. "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

3.6.1 Sub-Zone I -- Port of Lake Charles Approaches (NOAA Chart 11340)

This sub-zone lies seaward of a line drawn between Calcasieu Channel Lighted Buoys 3 and 4, extending westward to 93 degrees-24'W and eastward to 93 degrees-08'W; and thence from each intersection northward to the shoreline .

The sub-zone is critical to the queuing of inbound shipping to facilitate a one-way pattern of deep-draft traffic. Inbound traffic in the Approaches must report Estimated Time of Arrival (ETA) at Calcasieu Channel Lighted Whistle Buoy CC in sufficient time for orderly scheduling of entrance. The sub-zone is classified as "confined-simple" because of the strictures imposed by the Safety Fairway.

3.6.2 Sub-Zone II -- Calcasieu Entrance (NOAA Chart 11347)

This sub-zone lies between a line drawn between Calcasieu Channel Lighted Buoys 3 and 4 and one drawn between Calcasieu Channel Lights 47 and 48.

This sub-zone embraces the entire Calcasieu Entrance Channel and contains the Fairway Anchorage representing the only holding area located within the port system for inbound shipping awaiting entrance. The sub-zone is classified as "confined-simple."

3.6.3 Sub-Zone III -- Cameron Loop (NOAA Chart 11347)

This sub-zone lies between a line joining Calcasieu Channel Lights 47 and 48 and one joining Calcasieu Channel Lights 59 and 60. West Pass is included in Sub-Zone III.

This sub-zone encompasses that portion of the main channel which is impinged upon by offshore industry and fishing craft based upon facilities at Monkey Island, Cameron and the West Pass. Since radio communications between ships, the VTS and such craft are neither comprehensive nor consistent, surveillance is required to insure that deep-draft ships are not surprised by movements of "non-participants." There are two ferry crossings within the sub-zone, but only the one crossing the main channel is considered as having VTS implications. The sub-zone is classified as "confined-complex."

3.6.4 Sub-Zone IV -- Calcasieu Lake (NOAA Chart 11347)

This sub-zone is comprised of that portion of the waterway system lying between lines between Channel Light 59 and 60, and Calcasieu Channel Lights 89 and 90. That portion of the Choupique Island Loop east of Mud Lake is excluded.

This sub-zone is approximately 16 miles in length, requires no course changes and can generally be entered only at its north and south ends. It is, however, critical to the management of inbound traffic in order to avoid encounters at the junction of the Calcasieu Channel and the ICW. It offers an area within which to adjust vessel arrival times at Choupique Cutoff so as to minimize deep-draft/ICW interaction. The sub-zone is classified as "confined-simple."

3.6.5 Sub-Zone V -- Choupique Junction (NOAA Chart 11347)

This sub-zone is bounded on the south by a line between Calcasieu Channel Lights 89 and 90, on the west by the bridge over the ICW at Ellender, to the north by a line drawn between Calcasieu Channel Lights 97 and 98 and to the east by the Calcasieu Lock of the ICW. The sub-zone includes that portion of the Choupique Island Loop east of Mud Lake.

This sub-zone includes that area of the port where ICW and deep-draft traffic intermix and offers the highest probability of collision, between tows and between tows and deep-draft ships. The passive management measures currently in effect can break down if all ICW traffic does not consistently comply with them and a history of communications breakdowns indicates a need to back up security broadcasts by using surveillance devices to monitor both main channel and ICW traffic. The sub-zone is classified as "confined-complex".

3.6.6 Sub-Zone VI -- Lake Charles (NOAA Chart 11347)

This sub-zone consists of that portion of the port north of a line drawn between Calcasieu Channel Lights 97 and 98, and south of the I-10 bridge.

Traffic management requirements in this sub-zone are minimal and primarily relate to timing of deep-draft movements in keeping with the one-way traffic scheme, and passing outbound shipping safely through the ICW traffic flow. The sub-zone is classified as "confined-simple."

3.7 PROBLEM AREA IDENTIFIERS (TABLE 3-1)

3.7.1 PAI II-1. Fairway Anchorage

The Fairway Anchorage is sufficiently large to serve all ships in the entrance queue. A real-time picture of locations of those ships will help establish optimal spacing between inbound ships and can contribute to smoothing deep-draft/ICW intermixing at Choupique Cutoff.

3.7.2 PAI III-1. Cameron Loop "non-participants"

The offshore support and fishing craft based on Monkey Island, at Cameron and in the West Pass area are not required to participate in the existing VTS system. An ability to keep deep-draft traffic informed about smaller craft movements will contribute to a "surprise free scenario" and can be used to build confidence in the overall management system. A closer monitoring of the "non-participants" may contribute to smoother and safer merging at Choupique Cutoff.

3.7.3 PAI III-2. Cross-channel Ferry

The present VTS procedures calls for the ferry just north of Cameron to monitor Channels 13 and 16, and recommends that ships transiting the area communicate with the ferry to exchange information as necessary. Inclusion of the ferry within a surveillance system may relieve pilothouse workload and reduce the dependence upon communications.

TABLE 3-1. LAKE CHARLES PROBLEM AREA IDENTIFIERS

PAI LOCATION	PROBLEM/POTENTIAL PROBLEM	MANAGEMENT REQUIREMENT
II-1 Fairway Anchorage	Anchorage management critical to queuing and safety	Have real-time knowledge of ship location and movement coupled with ability to coordinate movements with queuing requirements
III-1 Cameron Loop	Offshore industry and fishing craft based in Cameron Loop area are "non-participants" in Channel 13 and VTS	Have real-time knowledge of both participant and "non-participant" locations and movement. Be able to correlate all movements, provide movement management advice and alerting
III-2 Cross-Channel Ferry	Coordination of ferry and deep-draft ship movements required to maximize safety. Currently accomplished by radio contact	Provide ferry movement and coordination recommendations to both ferry and deep-draft traffic, relieving pilots/ferry of some communications workload
V-1 Choupique Cut-off	Interactions between deep-draft and ICW traffic offers highest risk of accident	Manage traffic flows to prevent interaction between traffic
V-2 Devil's Elbow	Represents merge point between traffic flows at location where ICW traffic is negotiating a major turn	Manage traffic flows to prevent interaction between traffic

3.7.4 PAI V-1. Choupique Cutoff

Real-time information about ICW and main channel traffic at or near the Cutoff will permit better and safer management of the ICW-main channel interaction. While the primary goal must be to minimize the potential for collisions, an important secondary consideration is the reduction of ICW delays. This factor will become increasingly important as LNG traffic increases.

Consideration should be given to exploiting the ICW queuing imposed by the Calcasieu Lock.

3.7.5 PAI V-2. Devil's Elbow

The Devil's Elbow represents a merge point of deep-draft with ICW traffic at a point where ICW shipping is negotiating a major turn. Improved management will contribute to collision-avoidance and perhaps help minimize delays imposed upon ICW traffic by deep-draft movement. The latter will become increasingly important as LNG traffic increases.

Consideration should be given to exploiting the ICW queuing imposed by the Calcasieu Lock.

4.0 PORT ARTHUR-LAKE CHARLES HARBOR VTS DESIGN

4.1 INTRODUCTION

A detailed physical survey of Port Arthur and a literature survey of Lake Charles is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Summary and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 1). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

4.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS

systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

o The number and class of vessels which interact in this sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o Choosing a specific ADS solution for one sub-zone in one harbor may effect all the VTS designs for all the other sub-zones in all the other harbors.

4.1.2 Assumptions

The design of a VTS system for the Port Arthur/Lake Charles VTS zones starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o The climate is humid/sub-tropical with numerous foggy periods. Very heavy rain is not a significant factor.

- The traffic density at both ports is light but the existing traffic is energy intensive; movements of 2500 tanker movements and 40,000 barges occur annually. These figures do not include barge traffic passing through the port on the Intracoastal Waterway (ICW).

- The accident rate in these harbors has been low.

- The physical dimensions of these harbors are small; both are long, narrow, river type harbors.

- As recommended by the IMO, all vessels of 20 meters or more in length will be required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- Most of the energy terminals are located in the narrow Neches River area of Port Arthur and the upper reaches of the Calcasieu River in Lake Charles.

- Enforcement of harbor procedural regulations is limited.

- A voluntary vessel traffic service, operated by the Lake Charles pilots, exists in Lake Charles.

- A vessel traffic management system for deep draft ships is active in Port Arthur. This system is operated by the Sabine pilots and does not include Intracoastal Waterway (ICW) traffic.

- The life cycle of all system hardware is ten years.

4.2 PORT ARTHUR-LAKE CHARLES DESIGN DECISIONS

Because these ports are energy intensive and present the potential for a significant accident, a reasonably extensive surveillance system has been selected. The possible ecological damage and resultant public impact justifies more than a simple active communications/procedural VTS system.

Because both VTS zones are long and narrow with no intermediate anchorages, a deep draft vessel is forced to commit to a continuous transit. An exceptionally detailed procedural system (from entrance to terminal) with active surveillance at selected points is necessary. All sub-zones in both ports are closely linked in that adequate vessel traffic management demands the ability to predict any vessel encounter in the entire transit. Both ports presently have pilot operated traffic management control systems in place. The system in Port Arthur is based on a set of published "Guidelines" and in Lake Charles the pilots manage a voluntary "Vessel Traffic Service" (VTS). These existing procedural systems must form the core of any VTS to be established in one or both of these ports.

A study of the traffic flow, traffic level, and problem areas which require surveillance leads to the selection of two VTS control sectors. Sector 1 is made up of the Sabine Neches Waterway (Port Arthur); Sector 2 is comprised of the Calcasieu River (Lake Charles). Each sector consists of a long narrow zone so the data must be sectorable for efficient display and management. To minimize confusion, these two sectors are to have different VTS communications channels. The VTS communications is to be implemented with distributed low radiated power level communications sites to reduce interference. High radiated power level sites are provided in each sector to guarantee reliable coverage under all conditions. Only one VTC, located in the Sabine Neches area, is required to manage both waterways. A summary of the surveillance chosen for these VTS zones is contained in Figure 4-1.

4.2.1 Port Arthur Sub-Zone I -- Port Arthur Approaches

4.2.1.1 Discussion

This "confined-simple" sub-zone is comprised of a two-mile wide safety fairway outside of a line between Sabine Bank Channel Light Buoys #1 and #2. The fairway contains two associated fairway anchorages which are utilized to queue incoming vessels. The fairway has obstructions on both sides. The long narrow river-like nature of the port with no anchorages or lay berths inside the harbor requires a ship to complete its transit with no stops all the way to its terminal. There is a considerable length of one-way traffic channels and daylight-only transit for large tankers. Vessel entry and exit must therefore be carefully managed to avoid dangerous meeting situations. Both of these problems are currently being managed by the harbor pilots using VHF radio only. At the present time, low traffic levels of five to eight ship movements per day permit uncomplicated queuing and ship movement management.

4.2.1.2 Design

VTS implementation in this sub-zone provides communications coverage on a VTS Channel, Channel 13, Channel 16 and the pilot channel. Procedures similar to those currently enforced by the pilots are required to manage vessel entrance. This coverage is provided by a communications station located in Sub-Zone III. There is no current problem with deep draft ship identification in this area due to the low numbers of vessels. The active radar surveillance discussed under 4.2.3 Sub-Zone III also provides surveillance capability of the safety fairway and fairway anchorages.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-zone III
II																			Radar/Comms coverage from Sub-zone III
III			1							1	1		1	1					
IV	2									2	1	2							
V										1									
I																			Comms Coverage From Sub-Zone III
II																			Comms Coverage From Sub-Zone III
III										1	1		1		1			1	
IV	1									1									
V										1			1						
VI										1									

FIGURE 4-1. PORT ARTHUR SURVEILLANCE SURVEY (Top Half) and LAKE CHARLES SURVEILLANCE SURVEY (Lower Half)

No hardware is necessary. Some active surveillance and the required communications coverage is provided from facilities in Sub-Zone III.

This area is suitable for use of a vessel-based surveillance system (ADS) if it becomes necessary to have more data on vessels headed for the Port Arthur VTS zone or if traffic increases and queue management becomes a larger problem. At the present time, traffic density does not warrant use of this method of surveillance to manage the queue of arriving ships. If, however, a national or international requirement emerges, this sub-zone represents one area where such data could be usefully employed.

4.2.2 Port Arthur Sub-Zone II -- Sabine Bank Channel

4.2.2.1 Discussion

This "confined-complex" sub-zone is made up of the area from the COLREGS Demarcation line at the entrance to Jetty Channel south to Sub-Zone I. The eastern limit is 93 degrees 30 minutes West longitude and the western limit is 93 degrees 59 minutes West longitude. Deep draft vessels must transit carefully. The 800' wide deep draft Sabine Bank Channel is in the middle of a two mile wide safety fairway. It is well buoyed but does have obstructions on either side. Halfway through this sub-zone the Sabine Bank Channel crosses the inshore safety fairway at right angles. This fairway is used by coastal shipping and tugs with barges. The fairway anchorage at the NE corner of this intersection is used to organize the queue of entering vessels. Deep draft vessels also must be aware of shallow draft traffic that enters and leaves Sabine Pass outside of the buoyed channel.

The vessel interactions of chief concern in this area are:

- o Final queueing of entering vessels to insure no problems in the waterway. This includes surveillance of the fairway anchorage.

- o Deep draft ship/coastal vessel interactions in and around the intersection of the Sabine Bank Channel with the coastal safety fairway.

- o Ship/local traffic interactions in the Sabine Bank Channel and Sea Bar Channel. Local traffic is mainly tug/barge, fishing, and recreation vessels.

- o Ship navigation in the Sabine Bank Channel.

4.2.2.2 Design

The overall technological solution for Sub-Zone II is active radar surveillance combined with active communications monitoring of procedural rules. The radar facility to provide surveillance of this sub-zone is to be located in Sub-Zone III. A Module 3 radar is selected for this application because:

- o Very heavy rain for extended periods of time is not a problem in this location

- o The farthest point of Sabine Channel to be monitored is 20 nm from the proposed radar station. Since the Channel at that point is 800'wide (244m), a radar beamwidth of 0.4 degrees to resolve that distance in azimuth is necessary. At the northern end of the sub-zone where Sabine Bank Channel intersects Sea Bar Channel, the distance is only 5nm and the azimuth resolution of the radar is 81 m (266') or about one-third of the channel width. This performance is adequate to monitor vessel movements. The combined height of the radar antenna and target size must equal 320' to achieve this range.

- o The vessel interactions of interest involve a combinatio.. of many different types and a fail safe system of managing the entrance queue is needed.

Total communications coverage is provided by a new communications site co-located with the radar in Sub-Zone III. Also co-located with the radar/communications facility is a complete meteorological sensor suite to measure wind velocity/direction, air temperature and visibility.

4.2.3 Port Arthur Sub-Zone III -- Jetty channel, Pass Channel & Port Arthur Canal

4.2.3.1 Discussion

This "confined-simple" sub-zone is comprised of three narrow channels which total approximately 11.5 miles in length and vary from 500' to 800' wide with a depth of about 40 feet. Jetty Channel is well buoyed and has jetties on either side. Tidal currents can exceed 2.5 knots between these jetties and water depth is variable depending on wind direction and velocity. Neither Pass Channel nor Port Arthur Canal present any significant navigation problems. Inbound deep draft vessels are committed to complete transit to their berths since there are no anchorages or lay berths available. There is one federal anchorage in this sub-zone but it is presently full of old oil drilling rigs and of no use to shipping. There are no sharp turns and traffic interaction involves passing and meeting situations.

4.2.3.2 Design

In addition to observance of established procedural rules, the existing traffic density and management problems in this sub-zone requires no more than active communications coverage on the VTS Channel and Channel 13. However, the presence of a high quality surveillance radar installed for monitoring Sub-Zone II provides active radar surveillance throughout this sub-zone as well. Additionally, the only federal anchorage in this port (PAI-III-1) is in this sub-zone. Should the anchorage become actively used as a traffic management tool, it will also need this surveillance coverage.

A new Module 3 facility is to be located in the vicinity of Texas Point. This radar provides the surveillance required in Sub-Zone II. Co-located with this radar facility is a high and low radiated power communications capability (Modules 10 and 11) and a complete metereological/hydrological suite (Modules 13 and 15). The current and depth measurement capability is needed to monitor the variable water conditions in Jetty Channel.

4.2.4 Port Arthur Sub-Zone IV -- Sabine Neches Canal

4.2.4.1 Discussion

This sub-zone contains the most difficult conditions for vessel traffic management and the two "worst case" oil spill scenarios. Deep draft vessels and ICW traffic share the 700' wide Sabine Neches Canal. The deep draft traffic is limited to "one-way only," and no night passage is allowed for larger tankers. ICW traffic, which can include very large barge rafts, is not regulated. Deep draft vessel traffic splits at the upper end of the sub-zone. Some vessels enter the Neches River with its many oil, petrochemical, and LNG facilities, and others proceed up the Sabine Neches Canal, which narrows to 200 feet and also contains the ICW traffic. This interaction with unregulated ICW traffic on one of the busiest waterways sections in the U.S., produces the most dangerous traffic situation in the entire zone. The ICW traffic involved does not necessarily originate or terminate in this VTS zone.

4.2.4.2 Design

The technological solution chosen for this sub-zone is active radar surveillance, communications coverage and augmented procedural rules governing both deep draft and ICW traffic movement. The navigation problem in this area involves the merging of a substantial amount of ICW traffic with deep draft traffic and the detection and tracking of all vessels is paramount to safe operation. This sub-zone is unique in that there is a hazardous combination of traffic patterns at both ends

with a more benign management problem in between. After traffic enters the Sabine Neches Canal in either direction, highly accurate active surveillance can diminish to less accurate surveillance and situational advice. This is because once the vessels have merged at either end, the only measurement needed to provide useful traffic advisories is the along-canal progress toward the other end. This means that even though the two active radars are easily capable of covering the entire sub-zone, they can be operated on short (3nm) range scales most of the time and need provide high resolution only at short ranges. The most accurate information needed concerns the traffic situations developing at either end of the sub-zone. Due to the small size of these two areas and the significant amount of reduced visibility, Module I surveillance radar is selected for both locations. This type of radar can provide fail safe operation, very high detection percentages and the accuracy needed over an area of less than 3nm in radius.

The following hardware is located in this sub-zone:

Texaco Island -- one Module 1 radar facility
one Module 10 VHF facility
one Module 12 meteorological facility

Humble Island -- one Module 1 radar facility
one Module 10 VHF facility
one Module 11 VHF facility (required to guarantee communications reliability in the reaches of the port)
One Module 12 meteorological facility

ADS data from deep draft vessels so equipped are of minimal value in this sub-zone because the interactions of primary concern are between ocean-going and local vessels. By the time they reach this area, the location or identity of deep draft vessels is not an issue.

4.2.5 Port Arthur Sub-Zone V -- Port of Beaumont

4.2.5.1 Discussion

This sub-zone is the Neches River from the Port of Beaumont to a point two miles west of Humble Island. It is a narrow (400' wide) channel and passes through substantial population centers. Petroleum, petrochemical and LNG terminals line the river. The traffic includes a mix of deep draft vessels, vessels heading to or from the ICW (tugs, tows, etc.) and pleasure craft. The deep draft vessel movements are currently governed by published "guidelines" whereas all other traffic is not. The overall traffic density is low.

4.2.5.2 Design

The technological solution chosen for this sub-zone is active communications monitoring and procedural reporting. Procedural rules must be expanded to include local traffic movements, especially barge traffic and hazardous material movements. The positive traffic surveillance at the Sabine Neches Canal entry of this sub-zone, the regulations in effect for movement within the Neches River, the overall low numbers of total vessel movements, and additional regulations for ICW-type of traffic is considered to be sufficient surveillance. The LNG movements up this river still require a moving safety zone. The hardware assigned to this sub-zone is:

- One Module 10 VHF facility is located near McFadden.

4.2.6 Port Arthur Sub-Zone VI -- Port of Orange

4.2.6.1 Discussion

This sub-zone is a section of the Sabine Neches Canal and the Sabine River up to the Port of Orange. The canal portion is only 200' wide and is used by both deep draft and ICW traffic. The overall traffic density is very low.

4.2.6.2 Design

The technological solutions chosen for this sub-zone are active communications monitoring and increased procedural reporting. Active radar surveillance of the lower portion of this sub-zone up to at least West Pass is provided by the Humble Island radar site. The volume of deep draft traffic going to the Port of Orange (approximately 2 per week) is readily managed by procedures and communications. The hardware selected for this sub-zone is:

- One Module 10 VHF facility near the ICW/Sabine River intersection.

4.2.7 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels without loss of effectiveness. Two watchstanders with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The vessel traffic center is located in the Sabine Neches area in a location with good visual surveillance of the ship channel. The center is to employ the following equipment:

4.2.7.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display will also be provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

4.2.7.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allow monitoring and transmission on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

4.2.7.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

4.2.7.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. A spare set of recording equipment is to be installed for redundancy purposes.

4.3 LAKE CHARLES DESIGN DECISIONS

4.3.1 Lake Charles Sub-Zone I -- Port Approaches

4.3.1.1 Discussion

This long, narrow sub-zone is made up of the safety fairway which serves as the approach to the Calcasieu River system. It is used to organize the queue of entering vessels. The fairway is two miles wide with no major navigational hazards on either side.

Pilot Boarding Area #3 is in this sub-zone and is used to board vessels with a draft over 35'. The existing VTS requires inbound vessels to report Estimated Time of Arrival in this sub-zone.

4.3.1.2 Design

VTS implementation in this sub-zone is complete communications coverage on a VTS channel, Channel 13, Channel 16 and the pilot channel (66A). Current or similar procedures are enforced to manage vessel entrance into this waterway as is now accomplished by the pilots. This coverage is provided by a communications station located in Sub-Zone III. There is no problem with deep draft ship identification in this area due to the number of vessels and the requirement that vessels give advance notice of arrival.

No hardware is necessary. Communications coverage is provided by facilities in Sub-Zone III.

This area is suited for a vessel-based surveillance system if it becomes necessary to have more data on vessels headed for the Port Arthur VTS zone. Since the pilots board ships some distance offshore (particularly at Boarding Area #3), a carry-on type of ADS device can be useful to monitor progress through Sub-Zones II, III and IV. This would be valuable if traffic levels increase enough to require more than a routine progress report. At the present time the number of vessels does not warrant this method of surveillance to queue ships. If a national or international requirement does emerge for deep draft ADS carriage, this sub-zone is a likely candidate area for effective use.

4.3.2 Lake Charles Sub-Zone II -- Calcasieu Entrance

4.3.2.1 Discussion

Sub-Zone II is composed of 17 miles of 800' wide channel in the center of a safety fairway. The safety fairway intersects the inshore fairway for traffic from the west. This traffic does not cross the ship channel. The only place vessels can be held in the entire river transit is at the fairway anchorage to the east of the fairway. Pilot Boarding Area #1 is used for vessels with 30' or less of draft; Pilot Boarding Area #2 is for vessels with 30-35' of draft. The channel is well buoyed with no radical turns and no serious navigation problems. Depending on wind speed and direction, cross channel currents can develop at the entrance to the jetties. Traffic density is low.

4.3.2.2 Design

VTS implementation for this sub-zone is active communications plus detailed procedural reporting and movement control requirements. If a requirement develops in the future for more precise location or if traffic levels increase, an ADS carry-on type of device (Module 7) could service this sub-zone well. Meteorological and hydrological sensors are to be installed.

No hardware is necessary. The current sensor portion of the hydrological Module 15 is to be located at the end of the jetty in this sub-zone but the equipment is listed under Sub-Zone III.

4.3.3 Lake Charles Sub-Zone III -- Cameron Loop

4.3.3.1 Discussion

At only 4 miles of channel, this sub-zone is quite small. The major problem here is that the main ship channel passes through a small dense area of other water craft activity. Fishing and recreation smallcraft and offshore oil industry vessels are present at Monkey Island. Also, in the middle of the sub-zone, there is a ferry which crosses the main shipping channel. Since the maneuverability of the deep draft vessels is limited, it is of primary concern that local craft come out of the loop safely.

4.3.3.2 Design

The technological solution selected for this sub-zone is active communications coverage, increased reporting requirements, for all vessels of more than 20 meters and CCTV monitoring (Module 18). At current traffic levels, this surveillance provides sufficient information to manage Sub-Zone III. The CCTV will not be totally effective in low visibility but deep draft vessels are normally not moved through this sub-zone in low visibility. The hardware required for this sub-zone is:

<u>Monkey Island Site</u>
- One Module 10 (VHF)
- One Module 11 (VHF)
- One Module 13 (met)
- One Module 15 (hyd)
- One Module 18 (CCTV)

4.3.4 Lake Charles Sub-Zone IV -- Calcasieu Lake

4.3.4.1 Discussion

This sub-zone is 16 miles of 400' wide channel with no turns. The channel is well marked and presents no serious navigational problems. Vessel traffic is very light and no unexpected encounters occur because all movements are known to the pilot and the VTS in advance. The speed of vessels is varied in this sub-zone thereby controlling arrival times at Sub-Zone V where significant traffic problems can develop. The radar from Sub-Zone V coincidentally provides excellent surveillance of this sub-zone. Under the existing procedures, however, it is possible for a vessel which is not required to take a pilot to enter the river without notifying the local VTS.

4.3.4.2 Design

The technological solution chosen for this sub-zone is active communications monitoring and detailed procedural reporting. Since this sub-zone presents no significant hazards, no additional surveillance capability is necessary. A carry-on ADS type device would be practical if more careful position monitoring of a ship's progress up the channel is needed in the future. This entire sub-zone will be covered by radar surveillance from Sub-Zone V.

A Module 10 VHF facility is located near the middle of the sub-zone to provide ow radiated power level communications.

4.3.5. Lake Charles Sub-Zone V -- Choupique Junction

4.3.5.1 Discussion

This sub-zone is very small at approximately 12 square miles but represents the most serious navigational hazard in the port. In less than two miles of channel, deep draft vessels must merge with ICW traffic, make at least one critical turn, and cross the ICW oncoming traffic lanes at least one time. To compound this situation, the most difficult transit--into and out of the industrial canal--is made by LNG tankers.

4.3.5.2 Design

The technological solution chosen for this sub-zone is active radar surveillance coupled with communications coverage and procedural reporting. This selection is based on the existing traffic patterns, the presence of large quantities of petroleum, petrochemicals, and LNG and the subsequent need for accurate real time information in order to manage traffic flow. The detection and tracking of all vessels present is integral to safe

operation. A Module 1 radar provides sufficient accuracy over the area of interest. It is recommended that the Calcasieu Lock be utilized as a traffic regulating device, especially during LNG movements in and out of the industrial canal. Meteorological sensors are also needed tp monitor localized weather conditions. The hardware selected for this sub-zone is:

<u>Ellender Bridge Site</u>
One Module 1 (radar)
One Module 10 (VHF)
One Module 13 (met)

4.3.6 Lake Charles Sub-Zone VI -- Lake Charles

4.3.6.1 Discussion

Sub-Zone VI is comprised of over 20 miles of 200' wide channel. The channel is well marked and has several wide turns. The majority of petroleum and bulk cargo terminals are here. Traffic density is very light at approximately one movement per day and unexpected encounters are rare.

4.3.6.2 Design

Surveillance in this zone is active communications on all four channels (VTS, 13, 16, 66A) and increased procedural reporting for all vessels over 20 meters. This solution provides sufficient information at current traffic levels to guard against surprise encounters in this narrow channel. The hardware selected for this sub-zone is:

o One Module 10 VHF facility in the vicinity of the Citgo Refinery to provide low radiated power level communications.

4.3.7 Vessel Traffic Center (See Paragraph 4.2.7)

4.4 COST ESTIMATES

4.4.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Port Arthur/Lake Charles VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Para. 4.1.2.

4.4.2 Hardware

	Non-recurring	Recurring (10 yr)
Vessel Traffic Center (x $1000)		
Port Arthur		
VTS Console (w/all software)	$ 1000	
Comms Console	150	
Recording Equipment--4 sets	100	
SCADA Equipment--4 radar sites	200	
TOTAL	$ 1450	725

Port Arthur

	Non-recurring	Recurring
<u>Texas Point Site</u>		
Module 3 (radar)	400	400
Module 10 (VHF)	19	13
Module 11 (VHF)	48	20
Module 13 (met)	40	5
Module 15 (hyd)	50	5
Sub-total	557	443
<u>Texas Island Site</u>		
Module 1 (radar)	310	310
Module 10 (VHF)	19	13
Module 12 (met)	20	5
Sub-total	349	328
<u>Humble Island Site</u>		
Module 1 (radar)	310	310
Module 10 (VHF)	19	13
Module 11 (VHF)	48	20
Module 12 (met)	20	5
Sub-total	397	348
<u>McFadden Site</u>		
Module 10 (VHF)	19	13
<u>Sabine Rive Site</u>		
Module 10 (VHF)	19	13
SECTOR 1 TOTAL	$1341	$1145

Lake Charles

Cameron Loop Site		
Module 18 (CCTV)	117	50
Module 13 (met)	40	5
Module 15 (hyd)	50	5
Module 10 (VHF)	19	13
Module 11 (VHF)	48	20
Sub-total	$274	$93
Sub-zone IV Site		
Module 10 (VHF)	19	13
Ellender Bridge Site		
Module 1 (radar)	310	310
Module 10 (VHF)	19	13
Module 13 (met)	40	5
Sub-total	$369	$328
Lake Charles Site		
Module 10 (VHF)	19	13
SECTOR 2 TOTAL	$681	$447

Total Hardware Costs

VTC	$1450	$ 725
Sector 1	1341	1145
Sector 2	681	447
TOTAL	$3472	$2317

4.4.3 Preliminary Total Project Costs (x$1000)

Hardware $3472

Management, Engineering, etc. (70%)
Assumptions: Turnkey system, 2430
Procurement by integ.contractor, good
manufacturer support, some software
required, System Manual required

Installation site integration (22%)
764 Assumptions: Complete installation
by contractor, remote access no
problem, Spares & Training (10%) 347
Civil Engineering
Assumptions: Building required
at USCG Sabine Station, 3 Comm towers,
4 remote radar buildings, land acquisition
4 radar towers 3000
1 CCTV/microwave, no roads
PROJECT ESTIMATE: $10013

Data Base Management System 300
TOTAL: $10313

10-year O&M Recurring Hardware $2317

2 Watchstander x 5 = 10 man/years @ $50 K/yr 5000

1 Officer-in-Charge @ $50K/yr 500

1 Clerk @ $50K/yr 500

Data Base @ $10K/yr 100

TOTAL (10-year) $8417

TOTAL PROJECT -- 10 YEAR LIFE $18730

REFERENCES

1. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico and Virgin Islands, 21st Edition, NOAA, Washington, DC, p.229

2. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, Oct. 1984, pp.89-91.

3. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico and Virgin Islands, 21st Edition, NOAA, Washington, DC, pp.221-222

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix E   Zone 5 Port Arthur, TX

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone 501A		
2254	A	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)
2390	A	JOHNSONS BAYOU, LA.
2391	A	SABINE PASS HARBOR, TEX. (PART OF WATERWAY)
2394	A	ORANGE, TEX. (SABINE RIVER) (PART OF WATERWAY)
2395	A	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)
2416	A	PORT ARTHUR, TEX. (PART OF WATERWAY)
Subzone 502E		
2003	A	LAKE CHARLES DEEP WATER CHANNEL, LA.
2390	A	JOHNSONS BAYOU, LA.
2390	B	JOHNSONS BAYOU, LA.
2391	A	SABINE PASS HARBOR, TEX. (PART OF WATERWAY)
2391	B	SABINE PASS HARBOR, TEX. (PART OF WATERWAY)
2394	A	ORANGE, TEX. (SABINE RIVER) (PART OF WATERWAY)
2394	B	ORANGE, TEX. (SABINE RIVER) (PART OF WATERWAY)
2395	A	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)
2395	B	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)
2416	A	PORT ARTHUR, TEX. (PART OF WATERWAY)
2416	B	PORT ARTHUR, TEX. (PART OF WATERWAY)
Subzone 503E		
2003	A	LAKE CHARLES DEEP WATER CHANNEL, LA.
2254	A	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)
2254	B	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)
Subzone 504F		
2003	A	LAKE CHARLES DEEP WATER CHANNEL, LA.
2254	A	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)
2254	B	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)
2394	A	ORANGE, TEX. (SABINE RIVER) (PART OF WATERWAY)
2394	B	ORANGE, TEX. (SABINE RIVER) (PART OF WATERWAY)
2395	A	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)
2395	B	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)

Appendix E Zone 5 Port Arthur, TX 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 501A Port Arthur Approach

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	7,769,183	0	44,154	0	7,813,337
2	FOREST PRODUCTS	22	0	0	0	22
3	FISHERIES PRODUCTS	710	0	0	0	710
4	MINING PRODUCTS, NEC	208,901	0	641,133	0	850,034
5	PROC. FOODS & MFTRS, NEC	11,703,276	0	4,417,135	0	16,120,411
6	WASTE OF MANUFACTURING	102,529	0	692,430	0	794,959
1311	CRUDE PETROLEUM	0	47,277,125	0	8,889,226	56,166,351
1493	SULPHUR, LIQUID	0	447,307	0	17,644	464,951
2810	SODIUM HYDROXIDE (CAUSTI	228,063	0	192,468	0	420,531
2811	CRUDE PROD-COAL TAR-PET	65,717	0	21,519	0	87,236
2813	ALCOHOLS	0	430,204	0	757,335	1,187,539
2817	BENZENE AND TOLUENE	0	274,767	0	1,268,169	1,542,936
2818	SULPHURIC ACID	0	0	0	139,062	139,062
2871	NITROGEN CHEM FERTILIZER	0	50,116	0	26,281	76,397
2872	POTASSIC CHEM FERTILIZER	32	0	0	0	32
2911	GASOLINE, INCL NATURAL	0	4,719,120	0	2,925,101	7,644,221
2912	JET FUEL	0	616,346	0	279,455	895,801
2913	KEROSENE	0	17,091	0	337,520	354,611
2914	DISTILLATE FUEL OIL	0	2,933,612	0	2,098,559	5,032,171
2915	RESIDUAL FUEL OIL	0	2,727,569	0	4,607,267	7,334,836
2916	LUBRIC OILS-GREASES	0	2,065,044	0	1,023,769	3,088,813
2917	NAPHTHA, PETRLM SOLVENTS	0	2,649,615	0	1,162,580	3,812,195
2921	LIQUI PETR-COAL-NATR GAS	0	217,981	0	19,971	237,952
	Subzone Total :	20,078,433	64,425,897	6,008,839	23,551,939	114,065,108

Subzone 502E Sabine Pass

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	7,391,163	0	408,615	0	7,799,778
3	FISHERIES PRODUCTS	2	0	0	0	2
4	MINING PRODUCTS, NEC	12,055	0	1,016,010	0	1,028,065
5	PROC. FOODS & MFTRS, NEC	7,604,390	0	12,820,954	0	20,425,344
6	WASTE OF MANUFACTURING	113,646	0	1,532,750	0	1,646,396
1311	CRUDE PETROLEUM	0	33,228,657	0	12,602,520	45,831,177
1493	SULPHUR, LIQUID	0	447,307	0	219,196	666,503
2810	SODIUM HYDROXIDE (CAUSTI	1,249	0	236,661	0	237,910
2811	CRUDE PROD-COAL TAR-PET	65,717	0	437,528	0	503,245
2813	ALCOHOLS	0	416,204	0	1,680,858	2,097,062
2817	BENZENE AND TOLUENE	0	274,707	0	3,299,633	3,574,340
2818	SULPHURIC ACID	0	0	0	336,525	336,525
2871	NITROGEN CHEM FERTILIZER	0	50,038	0	414,807	464,845
2872	POTASSIC CHEM FERTILIZER	0	0	141,221	0	141,221
2873	PHOSPHA CHEM FERTILIZERS	0	0	72,483	0	72,483
2911	GASOLINE, INCL NATURAL	0	3,630,813	0	5,374,663	9,005,476
2912	JET FUEL	0	447,653	0	643,247	1,090,900
2913	KEROSENE	0	0	0	389,829	389,829
2914	DISTILLATE FUEL OIL	0	2,497,753	0	3,534,399	6,032,152
2915	RESIDUAL FUEL OIL	0	2,260,979	0	8,227,523	10,488,502
2916	LUBRIC OILS-GREASES	0	1,968,424	0	1,887,204	3,855,628
2917	NAPHTHA, PETRLM SOLVENTS	0	2,238,807	0	2,760,970	4,999,777
2921	LIQUI PETR-COAL-NATR GAS	0	4,239	0	504,343	508,582
	Subzone Total :	15,188,222	47,465,581	16,666,222	41,875,717	121,195,742

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 503E Calcasieu Pass

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	378,020	0	434,725	0	812,745
2	FOREST PRODUCTS	22	0	0	0	22
3	FISHERIES PRODUCTS	708	0	0	0	708
4	MINING PRODUCTS, NEC	196,846	0	944,475	0	1,141,321
5	PROC. FOODS & MFTRS, NEC	4,098,886	0	11,670,891	0	15,769,777
6	WASTE OF MANUFACTURING	25,927	0	880,464	0	906,391
1311	CRUDE PETROLEUM	0	14,048,468	0	9,545,064	23,593,532
1493	SULPHUR, LIQUID	0	0	0	201,552	201,552
2810	SODIUM HYDROXIDE (CAUSTI	229,312	0	279,217	0	508,529
2811	CRUDE PROD-COAL TAR-PET	0	0	432,809	0	432,809
2813	ALCOHOLS	0	14,000	0	1,049,773	1,063,773
2817	BENZENE AND TOLUENE	0	60	0	2,044,832	2,044,892
2818	SULPHURIC ACID	0	0	0	333,657	333,657
2871	NITROGEN CHEM FERTILIZER	0	78	0	439,288	439,366
2872	POTASSIC CHEM FERTILIZER	32	0	141,221	0	141,253
2873	PHOSPHA CHEM FERTILIZERS	0	0	72,483	0	72,483
2911	GASOLINE, INCL NATURAL	0	1,088,307	0	4,246,790	5,335,097
2912	JET FUEL	0	168,693	0	433,564	602,257
2913	KEROSENE	0	17,091	0	600,759	617,850
2914	DISTILLATE FUEL OIL	0	443,487	0	3,178,088	3,621,575
2915	RESIDUAL FUEL OIL	0	481,138	0	5,826,798	6,307,936
2916	LUBRIC OILS-GREASES	0	96,620	0	1,592,747	1,689,367
2917	NAPHTHA, PETRLM SOLVENTS	0	410,808	0	2,129,438	2,540,246
2921	LIQUI PETR-COAL-NATR GAS	0	213,742	0	496,356	710,098
	Subzone Total :	4,929,753	16,982,492	14,856,285	32,118,706	68,887,236

Subzone 504F Intracoastal

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	3,924,525	0	440,947	0	4,365,472
2	FOREST PRODUCTS	22	0	0	0	22
3	FISHERIES PRODUCTS	709	0	0	0	709
4	MINING PRODUCTS, NEC	202,864	0	1,225,225	0	1,428,089
5	PROC. FOODS & MFTRS, NEC	5,075,998	0	13,412,590	0	18,488,588
6	WASTE OF MANUFACTURING	41,852	0	1,540,973	0	1,582,825
1311	CRUDE PETROLEUM	0	23,046,477	0	13,664,060	36,710,537
1493	SULPHUR, LIQUID	0	355,382	0	217,602	572,984
2810	SODIUM HYDROXIDE (CAUSTI	229,312	0	327,165	0	556,477
2811	CRUDE PROD-COAL TAR-PET	4,084	0	437,796	0	441,880
2813	ALCOHOLS	0	199,490	0	1,736,218	1,935,708
2817	BENZENE AND TOLUENE	0	102,663	0	2,971,573	3,074,236
2818	SULPHURIC ACID	0	0	0	404,622	404,622
2871	NITROGEN CHEM FERTILIZER	0	28,774	0	440,118	468,892
2872	POTASSIC CHEM FERTILIZER	32	0	141,221	0	141,253
2873	PHOSPHA CHEM FERTILIZERS	0	0	72,483	0	72,483
2911	GASOLINE, INCL NATURAL	0	1,842,709	0	5,760,829	7,603,538
2912	JET FUEL	0	201,336	0	590,397	791,733
2913	KEROSENE	0	17,091	0	604,323	621,414
2914	DISTILLATE FUEL OIL	0	1,196,659	0	3,971,455	5,168,114
2915	RESIDUAL FUEL OIL	0	550,425	0	7,489,449	8,039,874
2916	LUBRIC OILS-GREASES	0	389,865	0	1,937,604	2,327,469
2917	NAPHTHA, PETRLM SOLVENTS	0	789,813	0	2,811,015	3,600,828
2921	LIQUI PETR-COAL-NATR GAS	0	213,879	0	510,291	724,170
	Subzone Total :	9,479,398	28,934,563	17,598,400	43,109,556	99,121,917

Appendix E ZONE 5 Port Arthur, TX 7/22/91

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 501A				
Passenger	0	0	650	650
Dry Cargo	724	1,418	6,374	8,516
Tanker	2,118	2,347	409	4,874
Dry Cargo Barge Tow	31	0	0	31
Tanker Barge Tow	130	0	0	130
Tug/Tow Boat	73	0	0	73
Subzone Total:	3,075	3,765	7,433	14,273
Subzone : 502E				
Passenger	0	0	650	650
Dry Cargo	602	1,086	1,862	3,550
Tanker	1,737	1,915	376	4,028
Dry Cargo Barge Tow	29	0	3,132	3,161
Tanker Barge Tow	118	0	14,638	14,756
Tug/Tow Boat	0	0	11,077	11,077
Subzone Total:	2,486	3,001	31,735	37,222
Subzone : 503E				
Passenger	0	0	75,416	75,416
Dry Cargo	122	332	4,636	5,090
Tanker	381	432	37	850
Dry Cargo Barge Tow	2	0	2,867	2,869
Tanker Barge Tow	11	0	10,731	10,742
Tug/Tow Boat	145	0	1,220	1,365
Subzone Total:	661	764	94,907	96,332
Subzone : 504F				
Dry Cargo	266	506	4,696	5,468
Tanker	732	810	109	1,651
Dry Cargo Barge Tow	4	0	3,582	3,586
Tanker Barge Tow	32	0	14,789	14,821
Tug/Tow Boat	138	0	6,259	6,396
Subzone Total:	1,172	1,316	29,435	31,923

Note: Sum of all vessel transits within each study subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 5 Port Arthur, TX

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	76,066	76,066
Dry Cargo	724	1,418	6,436	8,578
Tanker	2,118	2,347	411	4,876
Dry Cargo Barge Tow	31	0	3,855	3,886
Tanker Barge Tow	130	0	17,447	17,576
Tug/Tow Boat	73	0	12,057	12,130
Zone Total:	3,075	3,765	116,272	123,112

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix E ZONE 5 Port Arthur, TX

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 501A Port Arthur Approach		
2254	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)	3	3
2390	JOHNSONS BAYOU, LA.	3	3
2395	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)	3	3
2416	PORT ARTHUR, TEX. (PART OF WATERWAY)	3	3
	SUBZONE 502E Sabine Pass		
2003	LAKE CHARLES DEEP WATER CHANNEL, LA.	3	3
2390	JOHNSONS BAYOU, LA.	3	3
2395	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)	3	3
2416	PORT ARTHUR, TEX. (PART OF WATERWAY)	3	3
	SUBZONE 503E Calcasieu Pass		
2003	LAKE CHARLES DEEP WATER CHANNEL, LA.	3	3
2254	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)	3	3
	SUBZONE 504F Intracoastal		
2003	LAKE CHARLES DEEP WATER CHANNEL, LA.	3	3
2254	CALCASIEU RIVER AND PASS, LA. (LAKE CHARLES, LA.)	3	3
2395	BEAUMONT, TEX. (NECHES RIVER) (PART OF WATERWAY)	3	3

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix E Zone 5 Port Arthur, TX

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
502E	Sabine Pass	21,785	116.50
503E	Calcasieu Pass	16,046	119.75
504F	Intracoastal	7,720	1,072.22
	Total for Zone	45,551	28.74

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 501A				
Passenger	0	0	684	684
Dry Cargo	990	1,869	8,391	11,250
Tanker	2,467	2,207	433	5,107
Dry Cargo Tow	0	0	1,982	1,982
Tanker Tow	131	0	9,481	9,612
Tug/Tow Boat	0	0	13,191	13,191
Subzone Total:	3,588	4,076	34,162	41,826
Subzone : 502E				
Passenger	0	0	684	684
Dry Cargo	835	1,461	2,388	4,684
Tanker	1,959	1,829	373	4,161
Dry Cargo Tow	0	0	3,622	3,622
Tanker Tow	119	0	14,982	15,101
Tug/Tow Boat	0	0	11,891	11,891
Subzone Total:	2,913	3,290	33,940	40,143
Subzone : 503E				
Passenger	0	0	16,890	16,890
Dry Cargo	155	408	6,139	6,702
Tanker	508	378	64	950
Dry Cargo Tow	0	0	3,317	3,317
Tanker Tow	12	0	11,005	11,017
Tug/Tow Boat	0	0	1,300	1,300
Subzone Total:	675	786	38,716	40,177
Subzone : 504F				
Dry Cargo	352	645	6,221	7,218
Tanker	906	752	137	1,795
Dry Cargo Tow	0	0	4,142	4,142
Tanker Tow	33	0	15,091	15,125
Tug/Tow Boat	0	0	6,870	6,870
Subzone Total:	1,291	1,397	32,461	35,149

Note: Sum of all vessel transits within each study subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 501A				
Passenger	0	0	720	720
Dry Cargo	1,213	2,218	9,967	13,398
Tanker	2,771	2,340	481	5,592
Dry Cargo Tow	0	0	2,178	2,178
Tanker Tow	135	0	9,667	9,803
Tug/Tow Boat	0	0	15,165	15,165
Subzone Total:	4,119	4,558	38,178	46,855
Subzone : 502E				
Passenger	0	0	720	720
Dry Cargo	1,032	1,753	2,787	5,572
Tanker	2,167	1,942	408	4,517
Dry Cargo Tow	0	0	3,972	3,972
Tanker Tow	122	0	15,487	15,609
Tug/Tow Boat	0	0	13,688	13,688
Subzone Total:	3,321	3,695	37,062	44,078
Subzone : 503E				
Passenger	0	0	17,777	17,777
Dry Cargo	181	465	7,324	7,970
Tanker	604	398	77	1,079
Dry Cargo Tow	0	0	3,638	3,638
Tanker Tow	13	0	11,381	11,394
Tug/Tow Boat	0	0	1,476	1,476
Subzone Total:	798	863	41,673	43,334
Subzone : 504F				
Dry Cargo	422	750	7,423	8,595
Tanker	1,049	800	156	2,005
Dry Cargo Tow	0	0	4,543	4,543
Tanker Tow	36	0	15,585	15,621
Tug/Tow Boat	0	0	7,875	7,875
Subzone Total:	1,507	1,550	35,582	38,639

Note: Sum of all vessel transits within each study subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 501A				
Passenger	0	0	745	745
Dry Cargo	1,490	2,666	11,925	16,081
Tanker	3,133	2,517	546	6,196
Dry Cargo Tow	0	0	2,391	2,391
Tanker Tow	141	0	9,834	9,975
Tug/Tow Boat	0	0	17,638	17,638
Subzone Total:	4,764	5,183	43,079	53,026
Subzone : 502E				
Passenger	0	0	745	745
Dry Cargo	1,279	2,131	3,262	6,672
Tanker	2,414	2,091	457	4,962
Dry Cargo Tow	0	0	4,355	4,355
Tanker Tow	126	0	15,990	16,116
Tug/Tow Boat	0	0	15,945	15,945
Subzone Total:	3,819	4,222	40,753	48,795
Subzone : 503E				
Passenger	0	0	18,399	18,399
Dry Cargo	211	535	8,817	9,563
Tanker	719	426	93	1,238
Dry Cargo Tow	0	0	3,991	3,991
Tanker Tow	14	0	11,757	11,771
Tug/Tow Boat	0	0	1,694	1,694
Subzone Total:	944	961	44,751	46,657
Subzone : 504F				
Dry Cargo	506	882	8,938	10,326
Tanker	1,221	863	181	2,265
Dry Cargo Tow	0	0	4,981	4,981
Tanker Tow	38	0	16,072	16,111
Tug/Tow Boat	0	0	9,146	9,146
Subzone Total:	1,765	1,745	39,319	42,829

Note: Sum of all vessel transits within each study subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 501A				
Passenger	0	0	771	771
Dry Cargo	1,833	3,229	14,393	19,455
Tanker	3,580	2,737	624	6,941
Dry Cargo Tow	0	0	2,627	2,627
Tanker Tow	146	0	10,027	10,173
Tug/Tow Boat	0	0	20,734	20,734
Subzone Total:	5,559	5,966	49,175	60,701
Subzone : 502E				
Passenger	0	0	771	771
Dry Cargo	1,585	2,610	3,831	8,026
Tanker	2,718	2,275	517	5,510
Dry Cargo Tow	0	0	4,777	4,777
Tanker Tow	130	0	16,549	16,679
Tug/Tow Boat	0	0	18,773	18,773
Subzone Total:	4,433	4,885	45,218	54,537
Subzone : 503E				
Passenger	0	0	19,043	19,043
Dry Cargo	248	619	10,726	11,593
Tanker	862	462	111	1,435
Dry Cargo Tow	0	0	4,378	4,378
Tanker Tow	16	0	12,175	12,191
Tug/Tow Boat	0	0	1,961	1,961
Subzone Total:	1,126	1,081	48,394	50,601
Subzone : 504F				
Dry Cargo	608	1,045	10,874	12,527
Tanker	1,436	944	211	2,591
Dry Cargo Tow	0	0	5,464	5,464
Tanker Tow	42	0	16,616	16,658
Tug/Tow Boat	0	0	10,740	10,740
Subzone Total:	2,086	1,989	43,905	47,980

Note: Sum of all vessel transits within each study subzone.

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Appendix E ZONE 5 Port Arthur, TX

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
	1995 FORECASTED ZONE TOTALS			
Passenger	0	0	80,065	80,065
Dry Cargo	891	1,693	7,779	10,363
Tanker	2,467	2,207	435	5,109
Dry Cargo Tow	0	0	4,461	4,461
Tanker Tow	131	0	17,734	17,865
Tug/Tow Boat	0	0	13,191	13,191
1995 Zone Total:	3,489	3,900	123,665	131,054
	2000 FORECASTED ZONE TOTALS			
Passenger	0	0	84,274	84,274
Dry Cargo	1,023	1,889	8,770	11,682
Tanker	2,771	2,340	483	5,594
Dry Cargo Tow	0	0	4,894	4,894
Tanker Tow	135	0	18,268	18,403
Tug/Tow Boat	0	0	15,164	15,164
2000 Zone Total:	3,929	4,229	131,853	140,011
	2005 FORECASTED ZONE TOTALS			
Passenger	0	0	87,222	87,222
Dry Cargo	1,255	2,198	10,209	13,662
Tanker	3,133	2,517	548	6,198
Dry Cargo Tow	0	0	5,368	5,368
Tanker Tow	141	0	18,790	18,931
Tug/Tow Boat	0	0	17,639	17,639
2005 Zone Total:	4,529	4,715	139,776	149,020
	2010 FORECASTED ZONE TOTALS			
Passenger	0	0	90,273	90,273
Dry Cargo	1,545	2,662	12,316	16,523
Tanker	3,580	2,737	626	6,943
Dry Cargo Tow	0	0	5,891	5,891
Tanker Tow	146	0	19,375	19,522
Tug/Tow Boat	0	0	20,734	20,734
2010 Zone Total:	5,271	5,399	149,215	159,885

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix E Zone 5 Port Arthur, TX 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 501A Port Arthur Approach						
Passenger	Small	1	1	0	0	2
Tanker	Large	3	0	1	0	4
Dry Cargo Barge Tow	Small	1	1	0	0	2
Fishing	Small	3	2	0	0	5
Other	Small	4	0	0	0	4
Subzone Totals:		12	4	1	0	17
Subzone: 502E Sabine Pass						
Passenger	Small	1	0	0	0	1
Dry Cargo	Large	1	0	1	0	2
Tanker	Large	3	4	2	0	9
Dry Cargo Barge Tow	Small	2	2	0	0	4
Tanker Barge Tow	Large	2	0	0	0	2
Tanker Barge Tow	Small	12	1	3	0	16
Tug/Tow Boat	Small	3	0	0	0	3
Fishing	Small	1	0	0	0	1
Other	Small	3	3	0	0	6
Subzone Totals:		28	10	6	0	44
Subzone: 503E Calcasieu Pass						
Passenger	Small	2	0	1	0	3
Dry Cargo	Large	0	0	1	0	1
Dry Cargo	Medium	3	1	0	0	4
Dry Cargo	Small	1	0	0	0	1
Tanker	Large	1	0	2	0	3
Dry Cargo Barge Tow	Small	0	1	1	1	3
Tanker Barge Tow	Small	2	1	0	0	3
Tug/Tow Boat	Small	1	2	0	0	3
Fishing	Small	3	0	1	0	4
Other	Small	6	0	0	1	7
Subzone Totals:		19	5	6	2	32

Note: OTHER equals barge breakaways and weather caused vessel casualties.

Appendix E Zone 5 Port Arthur, TX 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 504F Intracoastal						
Dry Cargo	Medium	0	0	1	0	1
Dry Cargo	Small	1	0	0	0	1
Tanker	Large	1	1	0	0	2
Tanker	Medium	1	0	1	0	2
Dry Cargo Barge Tow	Small	1	0	0	0	1
Tanker Barge Tow	Small	6	0	0	0	6
Tug/Tow Boat	Small	0	1	0	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		11	2	2	0	15
Zone Totals:		70	21	15	2	108

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE E-8 ZONE 5, PORT ARTHUR, TX - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE E-9 ZONE 5, PORT ARTHUR, TX - CANDIDATE VTS DESIGN - 1995-2010

UNITS

2	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
1	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
9	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
2	Meteorological Module 12	- Air temperature, wind direction and speed
3	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
1	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
1	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix E Zone 5 Port Arthur, TX

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91

Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	5.62	.80	4.53	10.95
Dry Cargo	Large	1.13	.19	1.31	2.63
Dry Cargo	Medium	.84	.13	.31	1.28
Dry Cargo	Small	1.80	.21	.28	2.29
Tanker	Large	6.02	1.36	7.74	15.12
Tanker	Medium	.59	.05	.34	.98
Tanker	Small	.06	0.00	.04	.10
Dry Cargo Barge T	Small	6.32	1.92	2.04	10.27
Tanker Barge Tow	Large	.09	.04	.05	.18
Tanker Barge Tow	Small	22.62	3.96	12.26	38.84
Tug/Tow Boat	Small	1.22	.42	.72	2.36
		46.29	9.08	29.61	84.99

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	5,308	751	2,970	9,029
Dry Cargo	Large	1,556	338	411	2,306
Dry Cargo	Medium	1,249	252	93	1,594
Dry Cargo	Small	1,358	160	185	1,703
Tanker	Large	61,752	14,312	46,310	122,373
Tanker	Medium	1,470	143	270	1,882
Tanker	Small	71	0	12	83
Dry Cargo Barge T	Small	355	302	36	693
Tanker Barge Tow	Large	1,449	653	547	2,649
Tanker Barge Tow	Small	89,468	15,737	5,355	110,560
Tug/Tow Boat	Small	111	77	61	250
		164,146	32,726	56,250	253,122

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.36	.05	.29	.70
Dry Cargo	Large	.14	.02	.16	.33
Dry Cargo	Medium	.11	.02	.04	.16
Dry Cargo	Small	.12	.01	.02	.15
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.02
Tanker Barge Tow	Small	.05	.01	.03	.09
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.79	.12	.54	1.45
Candidate VTS Design - Dollars					
Passenger	Small	539,735.97	76,987.17	434,809.50	1,051,532.63
Dry Cargo	Large	212,542.07	35,257.34	246,616.10	494,415.51
Dry Cargo	Medium	157,516.19	24,672.52	58,528.79	240,717.51
Dry Cargo	Small	172,963.70	20,074.58	26,639.46	219,677.74
Tanker	Small	182.98	0.00	131.31	314.28
Dry Cargo Barge Tow	Small	20,883.90	6,340.73	9,760.63	36,985.26
Tanker Barge Tow	Small	67,109.05	12,256.06	34,962.30	114,327.41
Tug/Tow Boat	Small	4,039.04	1,379.01	2,384.41	7,802.46
Totals		1,174,972.91	176,967.41	813,832.48	2,165,772.80

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	4.27	.61	3.44	8.31
Dry Cargo	Large	.02	.00	.02	.04
Dry Cargo	Medium	.01	.00	.00	.02
Dry Cargo	Small	1.37	.16	.21	1.74
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.15	.05	.05	.25
Tanker Barge Tow	Small	.55	10	.30	.94
Tug/Tow Boat	Small	.03	.01	.02	.06
Totals		6.39	.92	4.03	11.35
Candidate VTS Design - Dollars					
Passenger	Small	1,016,331.78	144,968.12	818,753.50	1,980,053.40
Dry Cargo	Large	3,649.29	605.36	4,234.33	8,488.99
Dry Cargo	Medium	2,704.51	423.62	1,004.92	4,133.06
Dry Cargo	Small	325,693.53	37,800.76	50,162.54	413,656.82
Tanker	Small	319.72	0.00	229.44	549.15
Dry Cargo Barge Tow	Small	36,522.82	11,079.25	11,781.54	59,383.61
Tanker Barge Tow	Small	116,002.42	20,388.98	64,610.32	201,001.73
Tug/Tow Boat	Small	7,057.47	2,409.56	4,166.32	13,633.35
Totals		1,508,281.55	217,675.65	954,942.91	2,680,900.11

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	4.79	.53	1.43	6.75
Dry Cargo	Large	.84	.13	.13	1.10
Dry Cargo	Medium	.62	.09	.03	.74
Dry Cargo	Small	1.54	.15	.15	1.83
Tanker	Large	4.54	1.09	1.02	6.65
Tanker	Medium	.44	.04	.04	.53
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	4.82	.81	.28	5.91
Tanker Barge Tow	Large	.08	.02	.01	.11
Tanker Barge Tow	Small	17.26	1.67	1.71	20.64
Tug/Tow Boat	Small	.22	.05	.09	.35
Totals		35.17	4.59	4.89	44.65
Candidate VTS Design - Dollars					
Passenger	Small	1,632,906.74	182,050.05	728,889.00	2,543,845.78
Dry Cargo	Large	617,765.89	98,070.63	75,945.26	791,781.78
Dry Cargo	Medium	553,106.60	82,910.12	13,475.56	649,492.28
Dry Cargo	Small	293,033.70	27,654.85	37,308.25	357,996.80
Tanker	Large	3,571,553.38	856,389.43	2,185,822.44	6,613,765.26
Tanker	Medium	294,294.44	28,591.08	79,436.93	402,322.44
Tanker	Small	3,626.28	0.00	3,394.31	7,020.59
Dry Cargo Barge Tow	Small	279,896.73	47,056.27	14,416.47	341,369.47
Tanker Barge Tow	Large	12,823.30	3,194.50	2,095.10	18,112.90
Tanker Barge Tow	Small	1,224,299.29	118,750.26	154,066.41	1,497,115.95
Tug/Tow Boat	Small	15,411.15	3,379.52	8,846.57	27,637.24
Totals		8,498,717.48	1,448,046.71	3,303,696.30	13,250,460.49

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	1.27	.15	.40	1.81
Dry Cargo	Large	.34	.07	.17	.58
Dry Cargo	Medium	.26	.05	.04	.35
Dry Cargo	Small	.70	.07	.06	.84
Tanker	Large	1.86	.44	1.04	3.33
Tanker	Medium	.18	.02	.05	.24
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Small	1.33	.41	.18	1.91
Tanker Tow	Large	.01	.00	.01	.02
Tanker Tow	Small	4.78	.84	1.05	6.67
Tug/Tow Boat	Small	.10	.03	.02	.16
Totals		10.84	2.08	3.01	15.93
Candidate VTS Design - Dollars					
Passenger	Small	4,129.50	460.38	1,646.10	6,235.98
Dry Cargo	Large	3,180.59	747.50	348.99	4,277.08
Dry Cargo	Medium	2,357.15	523.09	82.82	2,963.07
Dry Cargo	Small	1,329.87	125.51	167.47	1,622.85
Tanker	Large	97,924.90	25,781.34	103,836.53	227,542.78
Tanker	Medium	2,228.71	214.09	418.61	2,861.41
Tanker	Small	45.73	0.00	20.72	66.45
Tanker Tow	Large	3,016.52	1,516.44	1,698.75	6,231.71
Tanker Tow	Small	313,403.89	49,837.29	67,478.49	430,719.67
Tug/Tow Boat	Small	185.51	40.68	103.66	329.85
Totals		427,802.37	79,246.32	175,802.14	682,850.83

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.09	.03	.12
Dry Cargo	Large	0.00	.02	.01	.03
Dry Cargo	Medium	0.00	.01	.00	.02
Dry Cargo	Small	0.00	.02	.00	.03
Tanker	Large	0.00	.16	.04	.20
Tanker	Medium	0.00	.01	.00	.01
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.22	.01	.23
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.45	.07	.52
Tug/Tow Boat	Small	0.00	.05	.00	.05
Totals		0.00	1.04	.17	1.21
Candidate VTS Design - Dollars					
Passenger	Small	0.00	517.59	146.34	663.93
Dry Cargo	Large	0.00	120.99	42.37	163.36
Dry Cargo	Medium	0.00	84.67	10.06	94.72
Dry Cargo	Small	0.00	134.96	8.97	143.93
Tanker	Large	0.00	879.18	250.17	1,129.35
Tanker	Medium	0.00	34.86	10.90	45.76
Tanker	Small	0.00	0.00	1.28	1.28
Dry Cargo Barge Tow	Small	0.00	1,238.25	65.86	1,304.11
Tanker Barge Tow	Large	0.00	91.00	1.48	92.48
Tanker Barge Tow	Small	0.00	2,228.01	367.97	2,595.99
Tug/Tow Boat	Small	0.00	269.30	23.31	292.61
Totals		0.00	5,598.82	928.71	6,527.53

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.01	.05	0.00	.06
Dry Cargo	Large	0.00	.02	0.00	.02
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.01	0.00	.01
Tanker	Large	0.00	.13	0.00	.13
Tanker	Medium	0.00	.01	0.00	.01
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.01	.12	0.00	.13
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.03	.25	0.00	.28
Tug/Tow Boat	Small	.00	.03	0.00	.03
Totals		.05	.62	0.00	.68
Candidate VTS Design - Dollars					
Passenger	Small	15,664.67	100,179.64	0.00	115,844.31
Dry Cargo	Large	0.00	34,900.90	0.00	34,900.90
Dry Cargo	Medium	0.00	25,029.94	0.00	25,029.94
Dry Cargo	Small	4,385.22	22,114.54	0.00	26,499.76
Tanker	Large	0.00	249,524.30	0.00	249,524.30
Tanker	Medium	4.57	9,840.78	0.00	9,845.35
Tanker	Small	130.26	0.00	0.00	130.26
Dry Cargo Barge Tow	Small	17,509.16	236,490.97	0.00	254,000.13
Tanker Barge Tow	Large	0.00	7,345.69	0.00	7,345.69
Tanker Barge Tow	Small	61,046.88	473,332.81	0.00	534,379.68
Tug/Tow Boat	Small	3,364.21	51,645.95	0.00	55,010.16
Totals		102,104.97	1,210,405.53	0.00	1,312,510.49

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix E Zone 5 Port Arthur, TX
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	.00	.18	.69	.15	1.03
ALCOHOLS	.00	.11	.38	.22	.71
SULPHUR, LIQUID	.00	.02	.08	.00	.11
KEROSENE	.00	.01	.05	.00	.07
JET FUEL	.00	.02	.07	.00	.09
DISTILLATE FUEL OIL	.02	.08	.37	1.98	2.45
RESIDUAL FUEL OIL	.03	.15	1.35	1.61	3.13
GASOLINE, INCL NATURAL	.03	.13	.61	.01	.78
CRUDE PETROLEUM	.29	1.02	.93	.09	2.33
	.37	1.74	4.53	4.07	10.71

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix E Zone 5 Port Arthur, TX
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	10,313	0	0
1996	0	662	12,304
1997	0	602	11,379
1998	0	548	10,536
1999	0	498	9,732
2000	0	452	8,598
2001	0	411	7,532
2002	0	374	5,309
2003	0	340	7,140
2004	0	309	6,603
2005	0	281	6,632
2006	0	255	5,071
2007	0	232	4,138
2008	0	211	4,560
2009	0	192	4,536
2010	0	174	4,200
	10,313	5,543	108,270

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	10,313	0	0
1996	0	842	15,632
1997	0	842	15,903
1998	0	842	16,198
1999	0	842	16,457
2000	0	842	15,994
2001	0	842	15,411
2002	0	842	11,949
2003	0	842	17,678
2004	0	842	17,982
2005	0	842	19,868
2006	0	842	16,711
2007	0	842	14,998
2008	0	842	18,183
2009	0	842	19,896
2010	0	842	20,262
	10,313	12,626	253,122

APPENDIX E

ZONE 5 - PORT ARTHUR, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur		(Port 5)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0501	102	1	Alewife	.0010	.0010	.0010	.0010
0501	102	3	Atlantic Stingray	0.0000	0.0000	0.0000	0.0000
0501	102	3	Gulf Kingfish	0.0000	0.0000	0.0000	0.0000
0501	102	5	Gulf Butterfish	.5920	.5920	.0790	.0395
0501	102	33	Spanish Mackerel	0.0000	0.0000	0.0000	0.0000
0501	102	42	Scaled Sardine	.0152	.0052	.0026	0.0000
0501	102	43	Atlantic Thread Herring	.0052	.0052	.0052	.0052
0501	102	43	Bay Anchovy	.0052	.0052	.0052	.0052
0501	102	43	Striped Anchovy	.0052	.0052	.0052	.0052
0501	102	44	Striped Mullet	.9700	.9700	.9700	.9700
0501	102	128	Searobins (all)	.0974	.1316	.0658	.0789
0501	102	130	Planehead Filefish	0.0000	.0158	0.0000	0.0000
0501	102	238	Gulf Menhaden	.2631	.1842	.2993	.0316
0501	103	8	Bluefish	.4800	.0070	.4800	.8600
0501	103	11	Silver Sea Trout	2.9250	3.7499	.9375	.4625
0501	103	11	Weakfish	.0015	.0015	.0015	.0015
0501	103	50	Bonito	.0300	.0300	.0300	.0300
0501	103	51	Jack	.0070	.0C70	.0070	.0070
0501	103	52	Amberjack	.0300	.0300	.0300	.0300
0501	103	54	Blue Runner	.0070	.0070	.0070	.0070
0501	103	55	Doulphin	.0030	.0060	.0030	.0030
0501	104	12	Tuna	.0080	.0080	.0080	.0080
0501	104	13	Swordfish	.0280	.0280	.0280	.0280
0501	104	14	Shark	.0100	.0100	.0100	.0100
0501	105	17	Summer Flounder	.0380	.2500	.2100	.2300
0501	105	56	Lefteye Flounders (all)	.2309	.3908	.6414	.3207
0501	105	57	Bay Wiff	0.0000	.1604	.1604	0.0000
0501	105	57	Fringed Flounder	.1604	.1604	.3208	.1604
0501	105	57	Gulf Flounder	.1604	.1604	.1604	.1604
0501	105	57	Ocellated Flounder	.1604	.1604	.1604	.1604
0501	105	57	Shoal Flounder	.1066	.1066	.1776	.0533
0501	105	237	Lesser Electric Ray	0.0000	0.0000	0.0000	0.0000
0501	105	237	Smooth Butterfly Ray	.1493	.2063	.2388	.2388
0501	105	242	Lined Sole	.1539	.1539	.1539	.1539
0501	106		Silver Perch	0.0000	0.0000	0.0000	0.0000
0501	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
0501	106	28	Tilefish	.0390	.0390	.0390	.0390
0501	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
0501	106	34	Harvestfish	.0118	.0237	.0237	.0197
0501	106	35	Atlantic Croaker	28.8651	17.9605	3.3848	.1538
0501	106	36	Banded Drum	.0789	.2525	.0789	.0395
0501	106	36	Star Drum	2.9605	3.5526	3.5526	.1480
0501	106	37	Spot	1.1842	.2369	.0592	.0592
0501	106	40	Black Edge Cusk Eel	0.0000	0.0000	0.0000	0.0000
0501	106	40	Eels	.0011	.0011	.0011	.0011
0501	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0501	106	47	Sand Sea Trout	3.1249	3.7499	.6250	.1875
0501	106	48	Gafftopsail Catfish	.2130	.2130	.2130	.2130
0501	106	48	Hardhead Catfish	2.2203	.1332	.2220	.0710
0501	106	60	Longspine Porgy	2.5526	.2553	.5106	1.2763
0501	106	60	Porgies	.2000	.2000	.2000	.2000
0501	106	61	Florida Pompano	.0070	.0070	.0011	.0070
0501	106	62	Grunt	.0120	.0120	.0120	.0120

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur		(Port 5)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0501	106	63	Pinfish	.0263	.0164	0.0000	0.0000
0501	106	64	Southern Kingfish	.0395	.0329	.0822	.0789
0501	106	69	Red Snapper	0.0000	.1910	0.0000	0.0000
0501	106	71	Gulf Hake	0.0000	0.0000	0.0000	0.0000
0501	106	71	Southern Hake	.0158	0.0000	0.0000	.0158
0501	106	71	Spotted Hake	.0158	.0158	.0158	.0158
0501	106	76	Black ear Bass	0.0000	0.0000	0.0000	0.0000
0501	106	76	Rock Sea Bass	.0513	.0257	.0513	.0342
0501	106	76	Sea Bass	.0513	.0342	.0513	.0342
0501	106	77	Gray Triggerfish	0.0000	0.0000	0.0000	0.0000
0501	106	131	Rough Scad	0.0000	0.0000	0.0000	0.0000
0501	106	132	Singlefoot Frogfish	.0473	.0473	.0473	.0473
0501	106	133	Other Batfish	.0197	.0197	.0394	.0197
0501	106	133	Pancake Batfish	.0395	0.0000	.0395	0.0000
0501	106	134	Inshore Lizardfish	.0631	.0316	.0631	0.0000
0501	106	135	Atlantic Medshipmen	0.0000	.0237	.0118	0.0000
0501	106	239	Atlantic Bumper	.0189	.4737	.0189	0.0000
0501	106	240	Atlantic Moonfish	.0189	.0189	.0126	0.0000
0501	106	241	Pigfish	.0164	.0329	.0329	0.0000
0501	106	243	Hog Choker	.0158	0.0000	0.0000	.0158
0501	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
0501	108	25	Brown Shrimp	.0120	.0790	.0039	0.0000
0501	108	25	Pink Shrimp	0.0000	0.0000	.0490	0.0000
0501	108	25	White Shrimp	.0493	.0493	.0543	.0049
0501	108	209	Blue Crab	.0040	.0040	.0020	.0040
0501	108	217	Crabs , Other	.0010	.0010	.0010	.0010
0501	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
0501	108	234	Rock Shrimp	.0009	0.0000	0.0000	0.0000
0501	108	236	Seabob Shrimp	.0013	.0040	.0016	0.0000
0501	108	298	Other Shrimp	.0024	.0024	.0024	.0024
0501	109	207	Squid	.0083	.0830	.0830	.0083
0502	102	3	Gulf Menhaden	2.0300	3.5000	3.5000	2.0300
0502	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0502	105	17	Summer Flounder	.0380	.2500	.2100	.2300
0502	105	56	Southern Flounder	.6300	.6300	.6300	.6300
0502	106	35	Atlantic Croaker	10.5000	20.5000	20.5000	10.5000
0502	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0502	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0502	106	45	Sheepshead	.0300	.0300	.0300	.0300
0502	106	46	Spotted Sea Trout	1.2000	1.2000	1.2000	1.2000
0502	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0502	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0502	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0502	106	58	Red Drum	.7800	.7800	.7800	.7800
0502	106	59	Black Drum	.4500	.4500	.4500	.4500
0502	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0502	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
0502	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0502	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0502	108	209	Blue Crab	.0036	.1200	.0036	.0080
0502	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
0502	108	215	Shrimp - White, Pink, Brn	13.6180	16.3500	15.5400	13.6180
0503	102	3	Gulf Menhaden	2.0300	3.5000	3.5000	2.0300

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Port Arthur	(Port 5)						
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0503	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0503	105	17	Summer Flounder	.0380	.2500	.2100	.2300
0503	105	56	Southern Flounder	.6300	.6300	.6300	.6300
0503	106	35	Atlantic Croaker	10.5000	20.5000	20.5000	10.5000
0503	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0503	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0503	106	45	Sheepshead	.0300	.0300	.0300	.0300
0503	106	46	Spotted Sea Trout	1.2000	1.2000	1.2000	1.2000
0503	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0503	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0503	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0503	106	58	Red Drum	.7800	.7800	.7800	.7800
0503	106	59	Black Drum	.4500	.4500	.4500	.4500
0503	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0503	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
0503	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0503	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0503	108	209	Blue Crab	.0036	.1200	.0036	.0080
0503	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
0503	108	215	Shrimp - White, Pink, Brn	13.6180	16.3500	15.5400	13.6180
0504	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0504	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0504	108	209	Blue Crab	.0036	.1200	.0036	.0080
0504	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur (Port 5)				Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0501	202	1003	Menhaden	1.8300	1.8300	0.0000	10.0650
0501	202	1042		100.0000	10.0000	1.0000	10.0000
0501	202	1043	Herring	10.0000	.5000	.5000	10.0000
0501	203	1199	Larvae	2.1000	2.0000	.1000	0.0000
0501	204	1199	Larvae	2.1000	0.0000	0.0000	0.0000
0501	205	1199	Larvae	.5000	1.0000	.1000	1.0000
0501	206	1199	Larvae	2.0000	3.0000	1.0000	2.0000
0501	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
0501	208	1199	Larvae	.0016	.0042	0.0000	0.0000
0502	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0502	202	1043		53.0700	311.1000	2.1960	4.0260
0502	202	1121		.0366	.0092	.0183	0.0000
0502	202	1127	Silverside	.1281	.0366	.2196	.0366
0502	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0502	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0502	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0502	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0502	206	1036	Drums	.0275	.0458	0.0000	.0183
0502	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0502	206	1063	Pinfish	0.0000	0.0000	0.0000	1.0065
0502	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0502	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0502	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0502	206	1120	Gobies	.0092	.1830	.0092	.0183
0502	206	1120	Naked Goby	.2745	.0549	.0366	.0732
0502	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0502	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0502	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0502	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0502	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0502	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549
0502	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0502	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0503	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0503	202	1043		53.0700	311.1000	2.1960	4.0260
0503	202	1121	Gobies	.0366	.0092	.0183	0.0000
0503	202	1127	Silverside	.1281	.0366	.2196	.0366
0503	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0503	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0503	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0503	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0503	206	1036	Drums	.0275	.0458	0.0000	.0183
0503	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0503	206	1063	Pinfish	0.0000	0.0000	0.0000	1.0065
0503	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0503	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0503	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0503	206	1120	Gobies	.0092	.1830	.0092	.0183
0503	206	1120	Naked Goby	.2745	.0549	.0366	.0732
0503	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0503	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0503	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0503	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0503	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0503	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur	(Port 5)			Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0503	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0503	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0504	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0504	202	1043		53.0700	311.1000	2.1960	4.0260
0504	202	1121		.0366	.0092	.0183	0.0000
0504	202	1127	Silverside	.1281	.0366	.2196	.0366
0504	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0504	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0504	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0504	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0504	206	1036	Drums	.0275	.0458	0.0000	.0183
0504	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0504	206	1063	Pinfish	0.0000	0.0000	0.0000	1.0065
0504	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0504	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0504	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0504	206	1120	Gobies	.0092	.1830	.0092	.0183
0504	206	1120	Naked Goby	.2745	.0549	.0366	.0732
0504	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0504	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0504	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0504	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0504	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0504	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549
0504	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0504	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur		(Port 5)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0501	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0501	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0501	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0501	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0501	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0501	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0501	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0501	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0501	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0501	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0501	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0501	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0501	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0501	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0501	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0501	111	515	Scaup	.6500	0.0000	.6500	.6500
0501	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0501	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0501	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0501	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0501	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0501	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0501	112	561	Louisiana Heron	17.0589	2.0500	2.0500	17.0589
0501	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0501	112	561	Snowy Egret	19.5585	16.0500	16.0500	19.5585
0501	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0501	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0501	113		Other Seabirds	2.3000	2.3000	2.3000	2.3000
0501	113	534	Tern	.1477	.1477	.1477	.1477
0501	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0501	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0501	113	548	Skimmer	.2002	.2002	.2002	.2002
0502	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0502	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0502	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0502	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0502	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0502	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0502	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0502	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0502	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0502	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0502	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0502	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0502	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0502	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0502	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0502	111	515	Scaup	.6500	0.0000	.6500	.6500
0502	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0502	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0502	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0502	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0502	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0502	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur (Port 5)

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0502	112	561	Louisiana Heron	17.0589	2.0500	2.0500	17.0589
0502	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0502	112	561	Snowy Egret	19.5585	16.0500	16.0500	19.5585
0502	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0502	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0502	112	564	Whitefaced Egret	.0182	.0182	.0182	.0182
0502	113	530	Cormorant	2.4124	2.4124	2.4124	2.4124
0502	113	534	Tern	5.8077	5.8077	5.8077	5.8077
0502	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0502	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0502	113	548	Skimmer	.0641	.0641	.0641	.0641
0503	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0503	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0503	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0503	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0503	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0503	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0503	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0503	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0503	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0503	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0503	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0503	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0503	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0503	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0503	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0503	111	515	Scaup	.6500	0.0000	.6500	.6500
0503	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0503	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0503	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0503	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0503	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0503	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0503	112	561	Louisiana Heron	17.0589	2.0500	2.0500	17.0589
0503	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0503	112	561	Snowy Egret	19.5585	16.0500	16.0500	19.5585
0503	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0503	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0503	112	564	Whitefaced Egret	.0182	.0182	.0182	.0182
0503	113	530	Cormorant	2.4124	2.4124	2.4124	2.4124
0503	113	534	Tern	5.8077	5.8077	5.8077	5.8077
0503	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0503	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0503	113	548	Skimmer	.0641	.0641	.0641	.0641
0504	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0504	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0504	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0504	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0504	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0504	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0504	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0504	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0504	111	512	American Coot	112.1000	0.0000	112.1000	112.1000

APPENDIX E

ZONE 5 - PORT ARTHUR, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Port Arthur		(Port 5)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0504	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0504	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0504	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0504	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0504	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0504	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0504	111	515	Scaup	.6500	0.0000	.6500	.6500
0504	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0504	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0504	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0504	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0504	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0504	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0504	112	561	Louisiana Heron	17.0589	2.0500	2.0500	17.0589
0504	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0504	112	561	Snowy Egret	19.5585	16.0500	16.0500	19.5585
0504	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0504	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0504	112	564	Whitefaced Egret	.0182	.0182	.0182	.0182
0504	113	530	Cormorant	2.4124	2.4124	2.4124	2.4124
0504	113	534	Tern	5.8077	5.8077	5.8077	5.8077
0504	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0504	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0504	113	548	Skimmer	.0641	.0641	.0641	.0641

APPENDIX F

NEW ORLEANS, LA

(ZONE 6)

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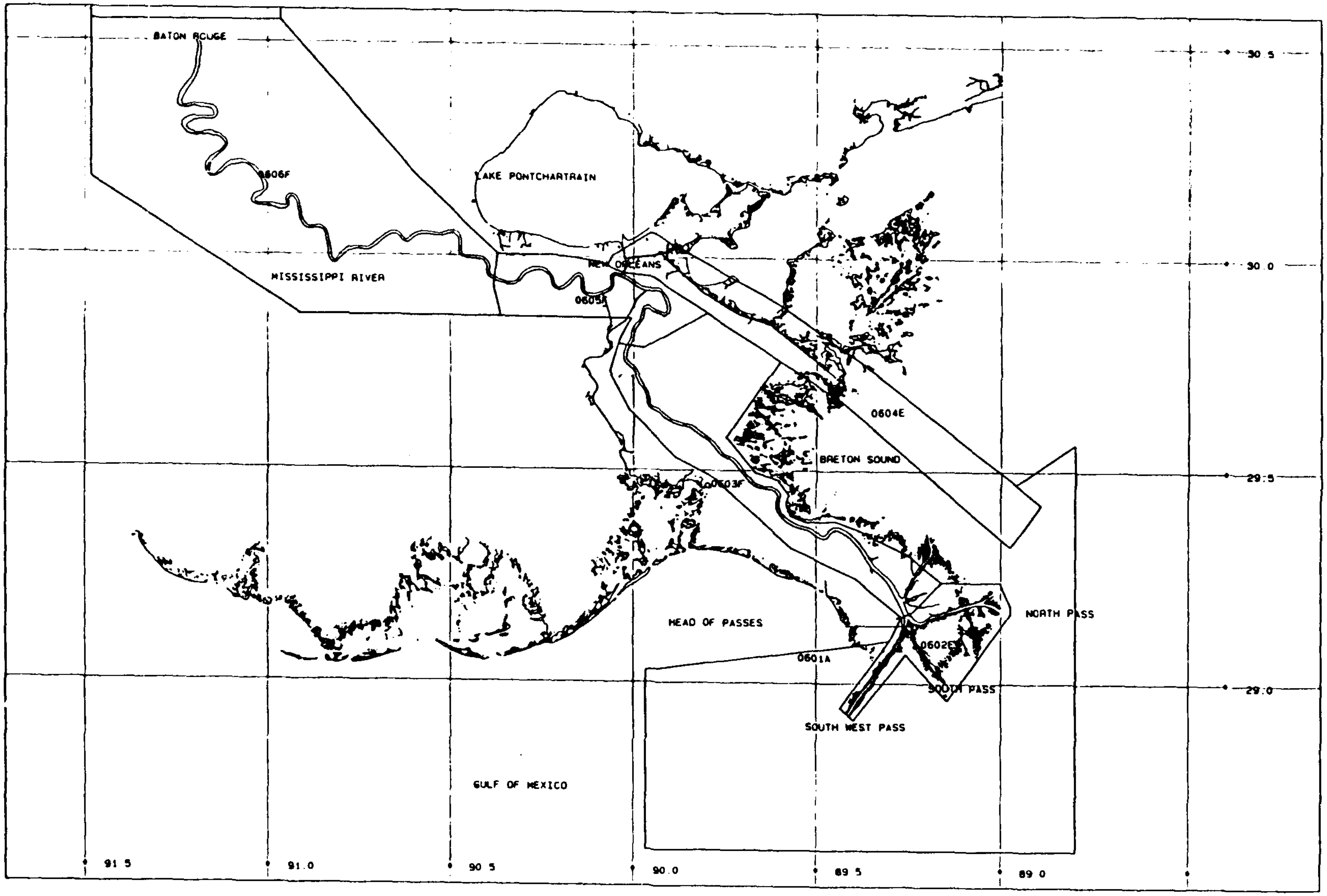
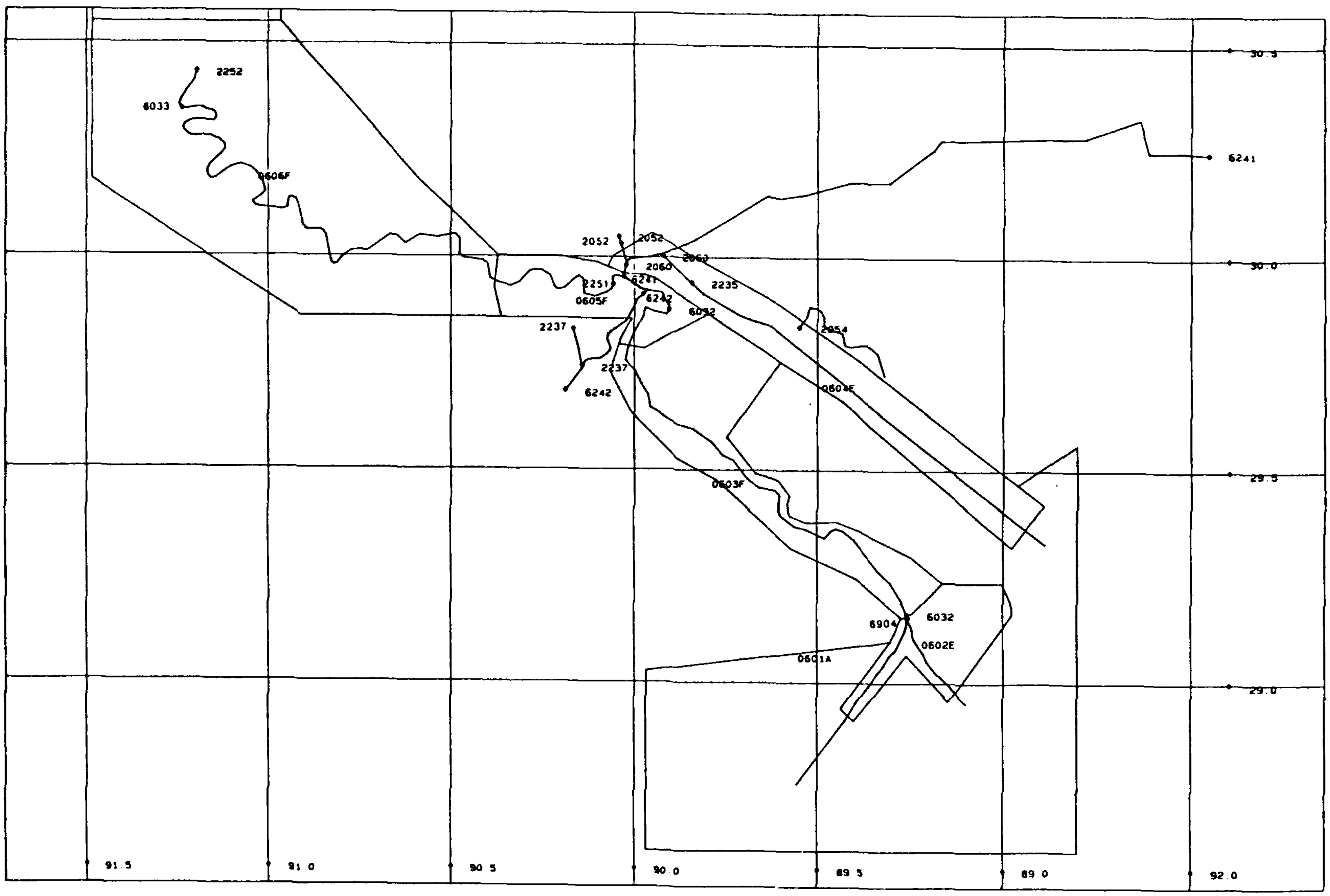
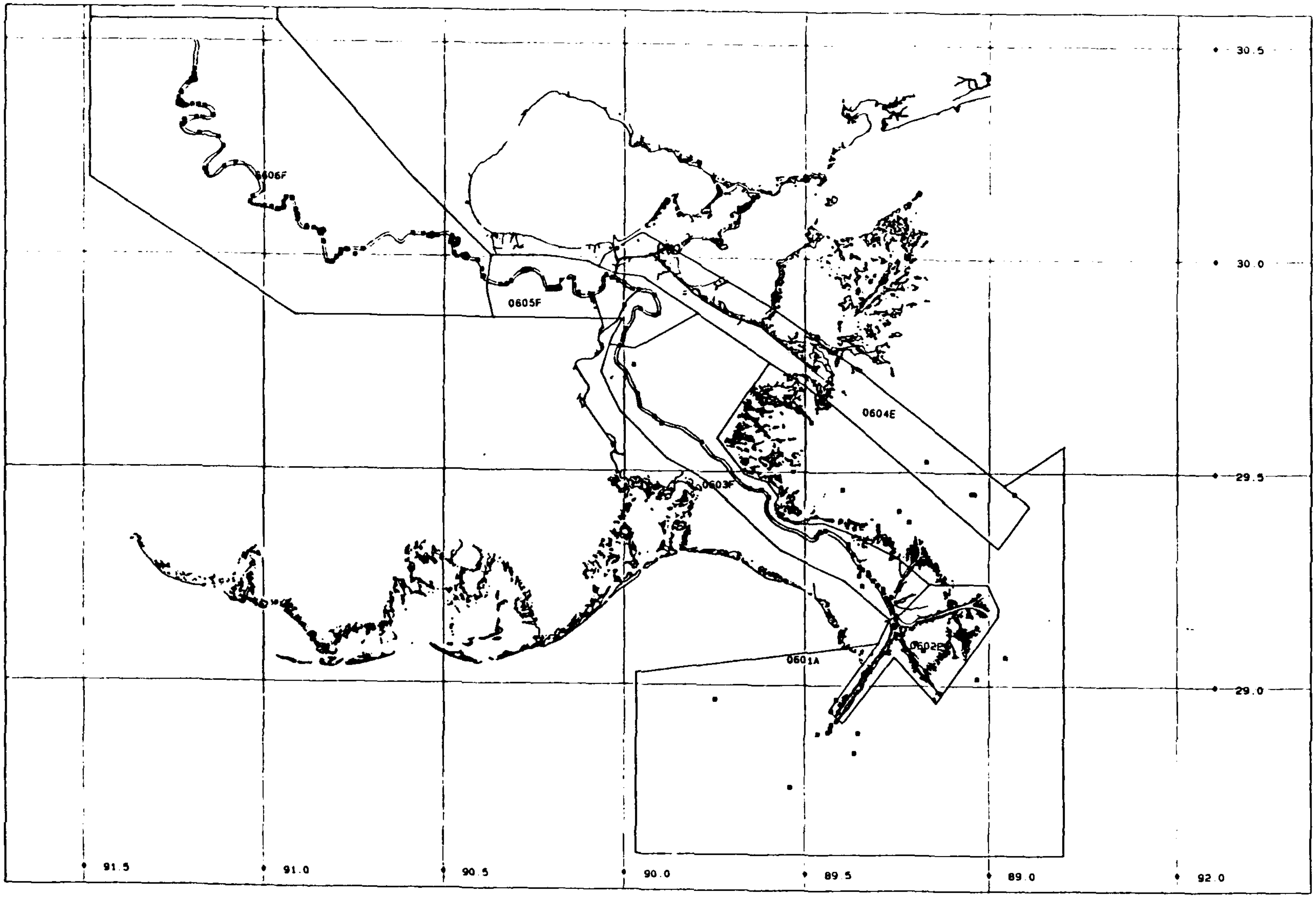
STUDY ZONE MAPS



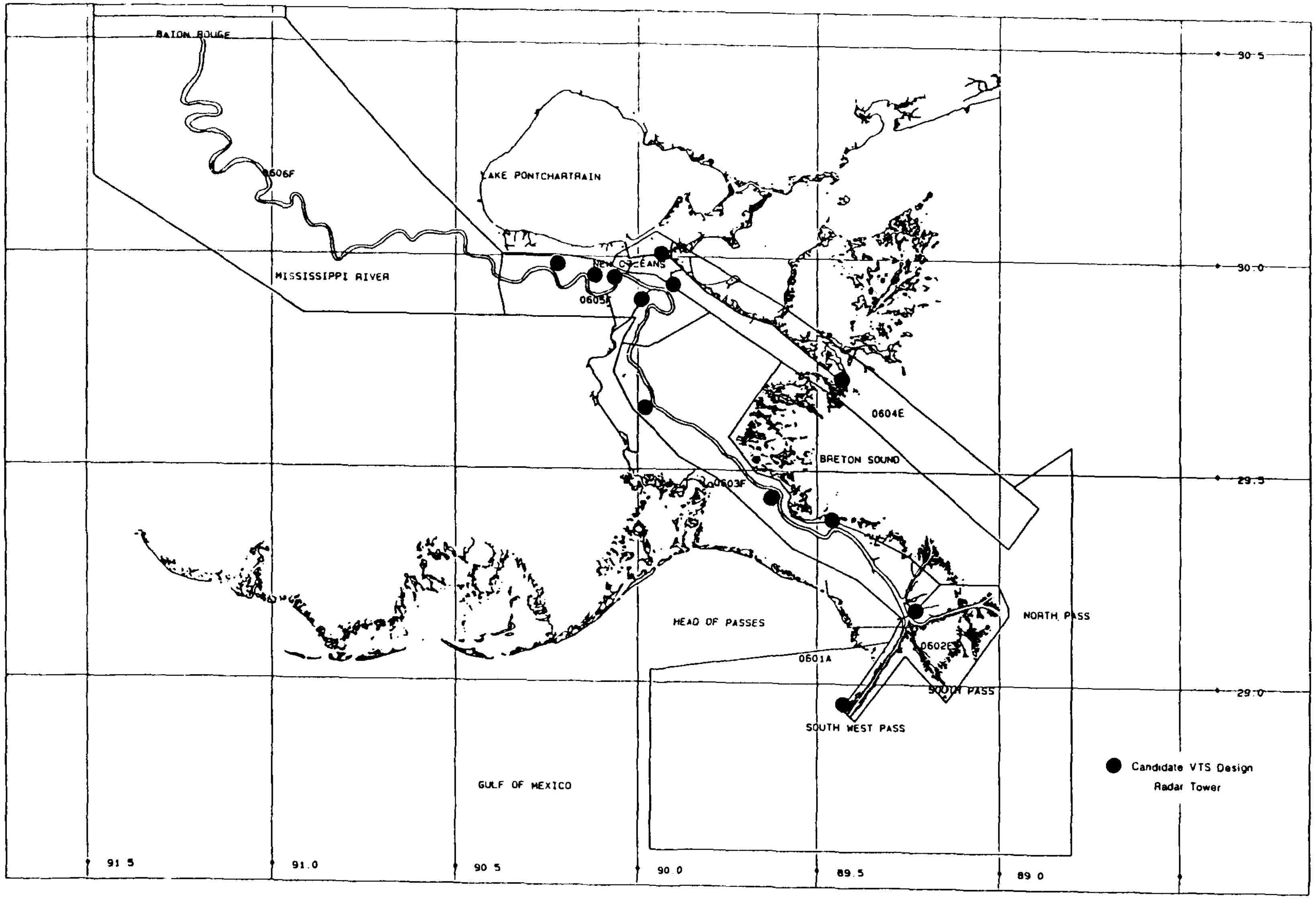
ZONE 6 - NEW ORLEANS, LA - ZONE AND SUBZONE BOUNDARIES



ZONE 6 - NEW ORLEANS, LA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 6 - NEW ORLEANS, LA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 6 - NEW ORLEANS, LA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

NEW ORLEANS, LA

(ZONE 6)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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LIST OF ILLUSTRATIONS

1.0 SCOPE

This report includes a port survey and a VTS design for New Orleans. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF NEW ORLEANS SURVEY

2.1 INTRODUCTION

The Port of New Orleans is one of the largest in the United States and is located on both sides of the Mississippi River between Mile 80.6 Above Head of Passes (AHP) [1] and Mile 115 AHP. The Study Area was extended beyond the port limits to include the seaward approaches and northward on the Mississippi River to Mile 122 AHP. Portions of the Intracoastal Waterway (ICW) and Mississippi River-Gulf Outlet Canal were also included. Expansion of the Study beyond the Port limits was required in order to provide timely movement input for New Orleans traffic management.

The Port of New Orleans is unique in that it is located some 100 miles upriver from the sea and because it serves three waterway complexes: Oceanic, entering from seaward; the Mississippi and Ohio Rivers system, and the Intracoastal Waterway (ICW). The shipping using each complex is different, in terms of handling and other characteristics, and intermixing of the various types adds complexity to traffic management requirements. A significant percentage of cargoes carried on all three waterway complexes consists, at least in part, of petro-chemicals and/or hazardous materials.

The Mississippi River itself also imposes special management concerns. At its Low Water Stage, for example, the low velocity of the current reduces downbound traffic problems but creates anchorage management concerns because ships tend to swing with the wind and intrude into the channel. During High Water, current velocities may exceed five knots. While this keeps

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[1] The U.S. Army Corps of Engineers has developed the convention of referring to locations on the Mississippi River in terms of distance from the "Head of Passes," an arbitrary measurement point established just south of the junction of the South and Southwest Pass.

anchored ships parallel to the banks, the strong current poses handling problems for downbound traffic.

Existing traffic management procedures are viewed by all parties interviewed as working effectively and safely. A major concern, common to all such informal arrangements, is that they rarely survive after-incident scrutiny. This concern is placed in perspective when one considers that a major marine incident involving toxic materials or explosives could wreck havoc upon the city and population of New Orleans.

2.2 OVERVIEW OF THE PORT

Deep-draft traffic enters the Port of New Orleans principally through the Southwest Pass and the Mississippi River-Gulf Outlet (MR-GO) Canal. The Southwest Pass Federal Project provides for a 45' channel over the bar, but the pilots recommend a limiting draft of 40' because that can generally be carried to New Orleans. The MR-GO has a limiting draft of 36'. South Pass is the only other improved Mississippi River channel, but it currently has a pilot-imposed draft limit of 15'. The approaches to both deep-water entrances can be made difficult by the poor quality of radar return from the low-lying land of the Mississippi Delta. Although the statistical occurrence of poor visibility is extremely low, averaging less than one percent of the time, mist or rain can compound the difficulty of landfall. These conditions are offset by excellent Loran-C coverage. Reliable groundwave signals can be obtained night and day from pairs 7980-W, 7980-X and 7980-Y. Excellent crossing angles and fix accuracies are provided by combinations 7980-W and 7980-X, 7980-W and 7980-Y, and 7980-X and 7980-Y, with fix accuracies of 0.1 nautical mile or less.

The Passes consist of narrow-banked deposits of sand and clay brought down by the river current. This process, by continuously adding to the seaward margins, extend the Delta seaward some 300 feet per year. The soft nature of the bottom and channel margins limit the consequences of groundings and, in fact, make deliberate grounding a useful tool by which to avoid other forms of casualty.

Tides in the Passes and Delta region generally have only one high and one low tide per 24 hour period, with the diurnal range varying from 0.9 to 1.4 feet. Up river, the effects of the tide are lost. The range at the Low Water Stage averages 0.8 foot, with no tide detectable during the High Water Stage.

River barge traffic peaks in volume at New Orleans and diminishes down river from that port. Offshore support and fishing craft frequent the River south of Venice and fishing craft also use the MR-GO. ICW traffic generally operates within the Study area only west of the intersection of the ICW and MR-GO westward to the ICW

locks on the west bank of the river. Within the Port of New Orleans proper all three types of traffic mix.

While there are presently numerous anchorages in the Mississippi River between Head of Passes and New Orleans, those for deep-draft ships are being steadily reduced as the result of U. S. Army Corps of Engineers (COE) river maintenance operations. The ready availability of anchorages is important to traffic safety, particularly during periods of poor visibility, and commercially important as part of the queuing scheme. The mooring, or "fleeting," of barges also has commercial significance and can be a traffic safety problem. Outside the designated anchorage areas emergency anchoring can cause significant problems because of the number of pipeline and other bottom crossings.

Nearly all of the container traffic of New Orleans enters through the MR-GO, because the principal container terminals are within the New Orleans Industrial Canal. Development of riverside container facilities is planned. Other traffic, both deep-water and barge, carries a surprisingly high--if unquantified--percentage of petro-chemicals and hazardous materials. Knowledge of hazardous cargo movements seems universally low.

The MR-GO represents a region of difficult and dangerous interactions between deep-draft ships and small vessels. Because of the narrowness of the channel a large ship pushes a wave ahead of it. As the ship comes abreast of a given point a suction effect is created that abruptly drops the water level in the channel and water is drawn off the banks. As the ship passes, the displaced water rushes back toward the banks and can capsize small craft. The violence of the sequence is a function of ship draft and speed.

2.3 EXISTING TRAFFIC MANAGEMENT

A "New Orleans Vessel Traffic Service Area" has been established by 33CFR161.401-33CFR161.402. The Area consists of all of the Mississippi River below Baton Rouge, including South and Southwest Passes. Administered by the Commander, Eighth Coast Guard District, traffic management within the Area is passive with the exception of control lights located in the vicinity of Algiers Point. The control light system is in effect during periods of high water and provides for one-way traffic around Algiers Point. A more detailed description may be found in the Coast Pilot (Reference 1).

The Mississippi River between Miles 88 and 127 AHP is a "Regulated Navigation Area", with a detailed series of requirements imposed primarily upon barges and barge mooring (fleeting) areas (Reference 2).

Pilotage is compulsory at the bars and on the river for all foreign ships over 100 tons and U. S.-Flag ships over 1,000 tons under register in foreign trade. Pilotage is optional for U. S.-Flag coastwise traffic having on board a pilot licensed by the Federal Government. There are four pilot organizations:

The Associate Branch Pilots, for the bars and Passes of the Mississippi River to Pilottown. They also provide assistance on the MG-GO from the entrance to the vicinity of Light 78, about 38 miles above the entrance.

The Crescent River Port Pilots, for the Mississippi River between Pilottown and New Orleans and the MR-GO north of Light 78.

The New Orleans-Baton Rouge Steamship Pilots for the river between New Orleans and Baton Rouge.

The Associated Federal Coast Pilots, Inc. providing services to public vessels and U. S.-Flag vessels in the coastwise trade.

The Associated Bar Pilots and the Crescent River Port Pilots constitute the two largest and busiest groups.

Traffic management in the Mississippi River is largely ad hoc in nature, and a matter left to a combination of the various pilots and commercial interests. Pilots handle the larger vessels and use CH67 on the River and CH13 in the Mississippi River-Gulf Outlet Canal (MR-GO) for Bridge-to-Bridge communications. The considerable barge traffic is managed individually by the tow boat operators themselves, who are motivated by schedules and competition.

Particularly during high river levels, the barge traffic tends to stay near edges of the river where currents are less. Large ship traffic coming down moves with considerable energy when the river is high creating interesting traffic situations with other upstream and down stream vessels and the barge traffic. Many blind turns require that pilots and tow boat operators make passing arrangements well before they are in sight of one another and this has contributed to misuse of the Bridge-to-Bridge Channel due to the need to use higher than 1-Watt power. The pilots control assignment of anchorages with the USCG COTP managing these "after the fact."

Neither CH67 or CH13 is officially monitored by the USCG COTP in the New Orleans area or anywhere along the river. These Bridge-to-Bridge communications channels are very congested and frequently misused. Because of thus meeting vessels frequently have to shift to high power (10 watts) to make meeting and passing arrangements with vessels in sight.

The Bar Pilots provide assistance and basic traffic management for all vessels which pilots from the Pass entrances to Pilottown. From there, the Crescent River Pilots handle traffic up the river. Information on ships in anchorage and all other pertinent river information is passed between the pilots by radio as they traverse the river and pass each other.

The river between Pilottown and about Mile 75 AHP is fairly benign with no remarkable crossing traffic and sufficient ahead visibility for effective Bridge-to-Bridge management. Starting at Mile 75 AHP, it becomes important to have an understanding of downbound traffic and the area between about Mile 75 AHP and the Huey P. Long Bridge (about Mile 121 AHP) is critical because of the several blind bends in the river, crossing ferries, and converging traffic from several canals. It is in this area that traffic control lights are utilized (during high river states) to regulate traffic from Southport (about Mile 105 AHP) to below Algiers Point (about Mile 90 AHP). These traffic lights were incorporated into the previously operated USCG Vessel Traffic System and presently are operated under the USCG COTP using civilian watchstanders (former Pilots). Communications with vessel traffic is normally on CH67 (reported usually at high power). A small shipboard type radar also is installed at Governor Nichols Wharf (the light control station) and used during periods of low visibility. Vessel air draft restrictions exist for the New Orleans Airport at Kenner Bend (about Mile 114.5 AHP).

In general, the Study group concluded that there is insufficient knowledge of overall river traffic by both the users and the USCG, in its regulator capacity. The USCG maintains no oversight of vessel traffic communications and this was cited by some users to be one of the more valuable functions of the now-disestablished VTS. There is general lack of coordination between vessels entering at the Passes and the anchorage assignments that might be required to accommodate them. The pilots report they are generally uninformed ahead of time regarding hazardous cargoes that they might encounter on a vessel they are piloting and may never know of such cargo that is onboard container vessels. English language problems apparently result in occasional on-board confusion regarding maneuvering orders and in determining vessel conditions (for example, calculations of the air draft, which is essential to under-bridge transits).

Traffic management on the MR-GO and the Intracoastal Waterway is similarly ad hoc, with CH13 used as the Bridge-to-Bridge radio channel. Both of these waterways are relatively straight with good visibility of oncoming traffic. The traffic situation becomes more critical at waterway junctions, and where ICW traffic mixes with deep-draft. One example of this occurs in the Inner Harbor Navigation Canal where most of the container and the bulk terminal facilities are located.

The Vessel Traffic Service Subcommittees of the Lower Mississippi River Waterway Safety Advisory Committee is well informed, and vocal, on New Orleans's requirements for Vessel Traffic Service. This subcommittee views a VTS as being "an information processing center" only, with the function of keeping users informed. In this context, VTS is considered as simply another "aid to navigation."

2.4 VESSEL TRAFFIC

Traffic statistics, expressed in numbers of vessel movements, tend to be unreliable because of the admixture. The Study assumes 3500 ship movements per year, not counting barge traffic, ferries or "light" tugs. The Port is also unique in that essentially no pleasure boating takes place within the Study area.

2.5 ENVIRONMENTAL SENSITIVITY

The Mississippi River poses some interesting environmental concerns, the most serious of which consist of potential threats to people rather than nature. The main channel and Port facilities are located in proximity to the largest population center in the Gulf Coast region and release into the atmosphere of toxic gases, a number of which are routinely carried and handled in large quantities on the River, will affect a large number of people. A major toxic release within the Port is considered by some of those interviewed to be the area's "worse case" scenario.

A unique and unusual concern stems from the potential for an out-of-control ship to breach a levee during High Water stage, releasing flood waters into residential and commercial areas. No effort was made to assess the validity of this concern, or the probability of occurrence.

Within the channeled confines of the levied Mississippi River the effects of an oil spill will probably be minimal, because the current will carry much of it to the sea within a matter of hours. Clean-up along the banks may be difficult and costly, but the environmental consequences are expected to be low. An exception to this occurs when the spill is near or enters potable

water intakes. Many of the population centers, including New Orleans, utilize the Mississippi River as a significant source of their potable water. Contamination of these intakes can result in serious health and public safety problems. Toxic spills may affect potable water to a greater degree than oil spills, and the consequences to the environment may well be more extensive. Spills and/or discharges which reach the sensitive wet lands of the Mississippi Delta may seriously impact aquatic birds, mammals and fish.

Detailed environmental sensitivity data, and forecast consequences of pollution incidents of various types, has been compiled by the National Atmospheric and Oceanic Administration, (NOAA) and may be obtained through its Western Region office.

2.6 PORT SUB-ZONES

The harbor was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 3).

Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-regions within which VTS needs are homogeneous.

2.6.1 Sub-Zone I - Southwest Pass Approaches (NOAA Chart 11361)

The Sub-zone includes that portion of the Safety Fairway lying within a 15 mile radius of Southwest Pass Entrance light to the Southwest Pass COLREG Demarcation Line established by 33CFR80.820 and 33CFR 80.830. The eastern limit of the sub-zone is at 89-15 West Longitude.

This sub-zone is important to New Orleans traffic management as a starting point for organization and queuing of the upriver traffic stream. By starting the management process in this sub-zone potentially dangerous meetings can be minimized and the use of anchorages as lay-berths reduced. The sub-zone is classified as "open-simple."

2.6.2 Sub-Zone II - South Pass Approaches (NOAA Chart 11361)

This sub-zone includes that portion of the Safety Fairway lying within a 15 mile radius of South Pass Light to the South Pass COLREG Demarcation Line established by 33CFR80.820 and 33CFR80.830. The western limit of the sub-zone is at 89-15 West Longitude.

This sub-zone is important to New Orleans traffic management as a starting point for organization and queuing of the upriver traffic stream. By starting the management process in this sub-zone potentially dangerous meetings can be minimized and the use of anchorages as lay-berths reduced. The sub-zone is classified as "open-simple."

2.6.3 Sub-Zone III - The Passes (NOAA Chart 11361)

This sub-zone includes those portions of the Mississippi River lying between the Southwest Pass and South Pass COLREG Demarcation Lines and a line drawn normal to the river's axis at Mile 13.5 AHP (Michella Light).

This sub-zone includes the junction of the Mississippi River with the South and Southwest Pass channels, a confluence area both of channels and of traffic. It also includes the operating bases of numerous offshore support craft and contains the point at which the Associated Bar and other pilots exchange responsibilities.

Because of the confluence, the nature of the traffic and the maneuvering incident to pilot exchange the sub-zone is considered to be "confined-complex."

2.6.4 Sub-Zone IV - Lower Mississippi River (NOAA Chart 11364)

This sub-zone includes that portion of the Mississippi River between a line drawn normal to the river's axis at Mile 13.5 AHP (Michella Light)and a line normal to the river's axis at Mile 71 AHP.

The sub-zone includes a fairly straight portion of the Mississippi River, where ahead visibility tends to be good. Barge traffic within the sub-zone is low to moderate and ICW shipping does not routinely enter it.

The sub-zone is classified "confined-simple."

2.6.5 Sub-Zone V - New Orleans (NOAA Chart 11369)

This sub-zone includes that portion of the Mississippi River between a line drawn normal to the river's axis at Mile 71 AHP and Mile 122 AHP. It also includes that portion of the Intracoastal Waterway (ICW) Algiers Alternate Route lying east of the Algiers Lock, south of Inner Harbor Navigation Canal lock

(about 0.6 miles east of the Mississippi River Levee), and east of Harvey Canal Lock.

This sub-zone contains the critical New Orleans anchorages and fleeting facilities, all of the Port's riverfront terminals and other facilities and is where river, ICW and deep-draft shipping share a common waterway. The Algiers Bend, addressed elsewhere also lies within the sub-zone. That portion of the sub-zone south of the New Orleans International Airport contains an area within which the movements of certain ships must be coordinated with air traffic.

The sub-zone is considered to be "confined-complex."

2.6.6 Sub-Zone VI - Upper Mississippi River (NOAA Chart 11369)

This sub-zone includes that portion of the Mississippi River upstream of a line drawn normal to the river's axis at Mile 122 AHP.

This sub-zone is important to New Orleans traffic management as a source of information about and "early warning" of southbound commerce which will enter the New Orleans area. There is significant mixing of traffic types and activities to warrant classification as "confined-complex."

2.6.7 Sub-Zone VII - Mississippi River-Gulf Outlet (MR-GO) Canal Approaches (NOAA Chart 11364)

This sub-zone includes that portion of the Safety Fairway lying within a 15 mile radius of Mississippi River-Gulf Outlet Approach Lighted Horn Buoy "NO" and the MR-GO Canal COLREGS Demarcation Line established by 33CFR80.820 and 33CFR80.830.

This sub-zone is important to New Orleans traffic management as a starting point for organization and queuing of the upriver traffic stream. By starting the management process in this sub-zone potentially dangerous meetings can be minimized and the use of anchorages as lay-berths reduced.

The sub-zone is classified as "open-simple."

2.6.8 Sub-Zone VIII - MR-GO Canal (NOAA Chart 11364)

This sub-zone includes that portion of the MR-GO Canal lying between the COLREG Demarcation Line established by 33CFR80.820 and 33CFR80.830 and a line drawn normal to the Canal's axis at Bayou Bienvenue.

The sub-zone contributes a number of elements to the traffic management equation. Deep-draft shipping in the MR-GO must be managed to avoid meetings of certain sized ships within its length, because entering ships must have a destination available to them upon arrival in New Orleans and because MR-GO deep-draft traffic mixes with ICW commerce during a shared portion of the canal.

The sub-zone is classified as "confined-complex."

2.6.9 Sub-Zone IX - New Orleans Industrial Canal (NOAA Chart 11369)

This sub-zone includes that portion of the MR-GO Canal and Inner Harbor Navigation Canal bounded by a line drawn normal to the Canal's axis at Bayou Bienvenue, the south lock of the Inner Harbor Navigation Canal, a line drawn in Lake Pontchartrain with a three mile radius from the North entrance to the Inner Harbor Navigation Canal, and that portion of the ICW Rigolets-New Orleans Cut west of a point one mile east of Chef Menteur Pass.

This sub-zone includes the busy inner harbor area within which are located many of the Port of New Orleans newest and busiest cargo terminals, including almost all of its container operations. There is a mixing of river barge, ICW and deep-draft traffic, a number of difficult bridge openings and the lock between the Canal and the river.

The sub-zone is classified as "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

2.7.1 PAI I-1. Southwest Pass Approaches

The Southwest Pass Approaches represent open water in which traffic can be safely regulated as part of the effort to manage traffic flow in the Mississippi River. By initiating the queuing process within this PAI it may be possible to minimize meeting and congestion problems upstream where options and freedom of movement are more severely limited.

2.7.2 PAI II-1. South Pass Approaches

The South Pass Approaches represent open water in which traffic can be safely regulated as part of the effort to manage traffic flow in the Mississippi River. By initiating the queuing process within this PAI it may be possible to minimize meeting and congestion problems upstream where options and freedom of movement are more severely limited.

TABLE 2-1. TABLE OF PROBLEM AREA IDENTIFIERS

PAI # LOCATION	PROBLEM/POTENTIAL PROBLEM	MANAGEMENT REQUIREMENT
I-1 South West Pass Approaches	Inception of queuing and point of decisions about timing of entries to avoid conflict.	Knowledge of ship movements Traffic Advisory Communications Up-to-date weather, tidal and current information
II-1 South Pass Approaches	Inception of queuing and point of decisions about timing of entries to avoid conflict.	Knowledge of ship movements Traffic Advisory Communications Up-to-date weather, tidal and current information
III-1 Intersection of SW Pass, South Pass, and the Mississippi River	Traffic convergence zone, mixing of unlike traffic	Knowledge of ship movements Navigational assistance during periods of low visibility, non-availability of pilots and similar circumstance Up-to-date weather, tidal and current information

TABLE 2-1. TABLE OF PROBLEM AREA IDENTIFIERS (Cont.)

V-1 Anchorages between Mile 71AHP and the Navigation Canal	Anchorage management is critical to collision avoidance and the management of traffic flow	Locations of ships in anchorages Knowledge of anchorage activity Navigational assistance during periods of low visibility, non-availability of pilots and similar circumstances Traffic Advisory Communications Up-to-date weather, tidal and current information
V-2 Mississippi River between Mile 88AHP and Twelvemile Point (Mile 109AHP)	Traffic through the vicinity of Algiers Point must be controlled during periods of high water to reduce risk of collision. VTS design must incorporate and maintain present light system.	Knowledge of ship movements Traffic Advisory Communications Up-to-date weather, tidal and current information

TABLE 2-1. TABLE OF PROBLEM AREA IDENTIFIERS (Cont.)

V-3 Mississippi River between Algiers Lock and Harvey Canal Lock	ICW traffic intermixes with Mississippi River deep-draft and tow/barge traffic, causing congestion	Knowledge of ship movements Navigational assistance during periods of low visibility, non-availability of pilots and similar circumstances Traffic Advisory Communications Up-to-date weather, tidal and current information
V-4 Mississippi River, immediately south of New Orleans Int. Airport	Ships with high air draft can interfere with airport glide paths	Knowledge of ship movements Traffic Advisory Communications Up-to-date weather, tidal and current information
V-5 New Orleans Fleeting areas	Enforcement of fleeting areas, particularly knowledge of intrusion into channel and break-aways essential to safety of navigation	Locations of ships in anchorages and knowledge of anchorage activities

TABLE 2-1. TABLE OF PROBLEM AREA IDENTIFIERS (Cont.)

VI-1 Mississippi River, North of Mile 122AHP	Knowledge of downbound shipping enroute to the Port of New Orleans is essential to traffic management	Knowledge of ship movements Traffic Advisory Communications
VII-1 MR-GO Approaches	Inception of queuing and point of decisions about timing of entries to avoid conflict	Knowledge of ship movements Up-to-date weather, tidal and current information
IX-1 New Orleans Industrial Canal	Mixing of ICW and MR-GO deep-draft traffic creates congestion, queuing problems	Knowledge of ship movements Traffic Advisory Communications Up-to-date weather, tidal and current information

2.7.3 PAI III-1. Intersection of Southwest Pass, South Pass and the Mississippi River.

This PAI represents a major traffic intersection where deep draft ships, the lighter users of the South Pass and an array of miscellaneous traffic meet.

2.7.4 PAI V-1. Anchorages between Mile 71 AHP and the Navigation Canal.

Anchorage management is one of the major keys to traffic management and the reduction of risk to deep draft ships transiting the Mississippi River.

2.7.5 PAI V-2. Mississippi River, between Mile 88 AHP and Twelve- mile Point (Mile 109AHP).

Traffic movement through the vicinity of Algiers Point represents one of the more hazardous passages, particularly during periods of high water. Passage of significant sized ships and tows through the area must be regulated to preclude meeting situations.

2.7.6 PAI V-3. Mississippi River Between Algiers Lock and the Harvey Canal Lock.

It is in this stretch of the Mississippi River that the traffic streams of the River and the ICW mix. The resulting congestion represents a collision hazard.

2.7.7 PAI V-4. Mississippi River, immediately south of New Orleans International Airport.

The passage and/or anchoring of ships with high air drafts can interfere with airport glide paths, requiring coordination of ship movement and air traffic.

2.7.8 PAI V-5. New Orleans Barge Fleeting Areas.

Enforcement of fleeting rules and confinement of moored barges to designated areas is essential to the ordered and safe flow of traffic on the river itself. Early knowledge of barge intrusion into the channel, or break-away from moorings, is essential for the safety of navigation.

2.7.9 PAI VI-1. Mississippi River, North of Mile 122 AHP

Knowledge of shipping enroute South into the Port of New Orleans area is essential to traffic management there.

2.7.10 PAI VII-1. Mississippi River-Gulf Access Canal (MR-GO) Approaches

The MR-GO Approaches represent open water in which traffic can be safely regulated as part of the effort to manage traffic flow in the MR-GO Canal. By initiating the queuing process within this PAI it may be possible to minimize meeting and congestion problems upstream where options and freedom of movement are more severely limited. Adequate knowledge of Approach traffic can be obtained through reporting procedures.

2.7.11 PAI IX-1. New Orleans Industrial Canal

The mixing of MR-GO deep draft and ICW traffic creates congestion and queuing problems.

3.0 PORT OF NEW ORLEANS VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of New Orleans is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The nine sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not

require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the New Orleans VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumption are as follows:

- o Long periods of very heavy rain are rare.

- o The traffic density in this port is light to moderate with approximately ten deep-draft movements per day in addition to tug/barge traffic.

- o This long river transit with its water level and current variations poses unique ship handling complications.

- o The VTS system must incorporate, existing, pilot-controlled procedures.

- o The Mississippi River and the Gulf Outlet Canal represent significantly different situations and are virtually independent of each other.

- o In most areas the banks of the river are undeveloped with few high structures. Large sections of the river south of New Orleans are tree-lined.

- o Most of the energy terminals are located in the New Orleans area.

- o The existing vessel management is distributed among several groups and agencies including the U.S. Coast Guard and the various pilot associations.

- o Reduction of bridge workload is vitally important in this river port. The workload on tugs and deep-draft vessels is already very high. On this river a practical VTS design must consider the existing bridge workload.

3.2 DESIGN DECISIONS

3.2.1 General

This river system represents a one-of-kind situation among major U.S. ports. To reach the port of New Orleans, ships must enter the channel in the Gulf of Mexico and proceed over 100 miles in a large river with variable currents and depths. The only physically similar situation where a VTS system is currently employed is on the northern German rivers. The extremely high traffic levels apparent in these rivers and the amount of piloting assistance furnished by the German VTC reduces applicability of these designs to the Mississippi River.

Analysis of the existing problem areas, traffic flow, traffic levels and the physical condition of the area has led to the following overall design decisions:

o Three control sectors are adequate for VTS monitoring of the zone if a high-level interactive software program is used. These are:

- Sector 1: Sub-Zones I, II, III and IV. This Sector includes the river approaches and the river up to mile 71 AHP.

- Sector 2: Sub-Zones V and VI. This Sector includes the Port of New Orleans and the river on either side.

- Sector 3: Sub-Zones VII, VIII, and IX. This Sector includes the New Orleans Industrial Canal and the Mississippi River-Gulf Outlet (MR-GO) Canal and its approaches.

o Each sector requires a different communications channel and distributed low-power communications sites to reduce interference and congestion.

o Automatic tracking and other software techniques are employed to reduce communications and therefore bridge workload for vessels in the system.

o Special efforts must be taken to inform vessels transiting the river of the vessel traffic, meteorological and hydrological condition. In the case of other vessel traffic, its description and the expected meeting or passing location and time are required by each pilot.

o The Vessel Traffic Center is located near Algiers Point with a good view of the river.

Figure 3-1 is a summary of the surveillance chosen for each sub-zone.

Sub-Zone IV presents a reasonable opportunity to employ carry-on type ADS devices. To compare this type of ADS with radar surveillance the following is assumed:

o Three Module 3 radar facilities are the minimum required for active surveillance of this area.

o Fifty portable ADS devices are required for deep-draft ships. These devices are to be carried by the river pilots.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I			1							1	1		1		1	1			These Facilities are Located in Sub-Zone III
II																			Comm and Radar Coverage of South Pass Entrance is From Sub-Zone III
III			1							1	1		1		1				Radar in Sub-Zone I also used for Sub-Zone III
IV			3							3	1		1						
V	5									3	1		2		1		2		
VI										1		1							
VII	1									1	1		1						These Facilities are Located in Sub-Zone VIII
VIII										3	1		1						Partial Radar Coverage FM Radar for Sub-Zone VII
IX	1									1			1						

FIGURE 3-1. PORT OF NEW ORLEANS, LA, SURVEILLANCE SURVEY

o All tugs and barges regularly trading in this sub-zone are required to be equipped with ADS devices.

o All other vessels over 20 meters using this sub-zone are required to report their positions frequently.

o The ADS system requires a dedicated VHF frequency.

Following is a cost comparison:

	(x$1000)			
	Non-recurring Government	Recurring Government	Non-recurring Non-government	Recurring Non-government
50 carry-on units Loran-C/VHF @ $1500 each	75	50	0	0
50 Tugs (Module 9)	58	10	200	100
Add'l. VHF radios	5	1	0	0
TOTAL:	138	61	200	100
			10-YEAR TOTAL COST:	$499
3 Radar Sites-- Module 3 radars, buildings, land, comms, etc. @ $800	2400	1500	0	0
			10-YEAR TOTAL COST:	$4M

Comparison: This preliminary analysis indicates that there are advantages and disadvantages to the use of ADS in this sub-zone. Three advantages are:

Advantage 1: The government cost is reduced by approximately 3.5 million dollars over the ten-year project life.

Advantage 2: Bridge workload is reduced for pilots in this region.

Advantage 3: The data can be used in Sub-Zone V to overlay active surveillance.

Disadvantages are:

Disadvantage 1: All vessels using this sub-zone that are not carrying a pilot or considered tugs that regularly trade in the area are tracked by reporting and dead reckoning above. This includes ships which are not required to take a river pilot, ICW traffic, fishing vessels and other occasional users.

Disadvantage 2: Tugs using this sub-zone which move commodities must be required to carry a Module 9 ADS device.

Disadvantage 3: The system can fail with the single backup being procedural reporting and dead reckoning.

Carry-on ADS technology is not selected for this design for these two major reasons:

1. The port survey does not contain enough detailed information regarding traffic levels, vessel types and numbers, and problem interactions to support use of carry-on ADS technology.

2. Strong opposition to this option was received via telephone conversations with river pilots who serve on the New Orleans VTS Advisory Committee. They cite severe problems with non-deep-draft vessels in this stretch of the river.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone I

SW Pass Entrance	1 Module 3 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET
	1 Module 15 HYD
	1 Module 16 DF

3.2.2.2 Sub-Zone II -- Communications and radar coverage of South Pass Entrance is from Sub-Zone III

3.2.2.3 Sub-Zone III -- Radar in Sub-Zone I also used for Sub-Zone III

Pilottown	1 Module radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET 1 Module 15 HYD

3.2.2.4 Sub-Zone IV

Fort Jackson	1 Module 3 radar 1 Module 10 VHF
Sixtymile Point	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET
Ironton	1 Module 3 radar 1 Module 10 VHF

3.2.2.5 Sub-Zone V

English Turn Bend	1 Module 1 radar 1 Module 13 MET
Saxonholm	1 Module 1 radar
Algiers Point (N. Bank)	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 15 HYD Vessel Traffic Center
Jefferson	1 Module 1 radar
Airport Turn	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET
Harvey Lock	1 CCTV Module 17
Algiers Lock	1 CCTV Module 17

3.2.2.6 Sub-Zone VI

Montz	1 Module 10 VHF 1 Module 11 VHF

3.2.2.7 Sub-Zone VII -- The required facilities are located in Sub-Zone VIII

MR-GO Jetty	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET

3.2.2.8 Sub-Zone VIII -- Partial radar coverage from radar for Sub-Zone VII

south of Bayou LaLoutre	1 Module 10 VHF
Shell Beach	1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET
Martello Castle	1 Module 10 VHF

3.2.2.9 Sub-Zone IX

MR-GO Bridge	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. Three watchstanders and a watch supervisor with integrated data workstations and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstanders be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One Commanding Officer, one Executive Officer, and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located at a new facility to be built in the vicinity of Algiers Point in a location with good visual surveillance of the river. The center is to employ the following equipment:

3.2.3.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as

interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.
- o Software providing the total integration of data from all VTS sensors.
- o Layering of data in at least four layers to be operator selectable.
- o The ability to sector data including sector to sector handoff of targets.
- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.
- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.
- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.
- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.
- o Complete modern color graphics capability with offset and zoom
- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.
- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.
- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the New Orleans VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x 1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (3 workstations one supervisory console & all software)	2500	
Communications console	200	
Recording Equipment	100	
SCADA Equipment (12 radar sites)	1000	
Sub-total:	3800	1500

Sub-Zone I

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 met	40	5
1 Module 15 hyd	50	5
1 Module 16 DF	90	5
Sub-total:	647	448

Sub-Zone II

No facilities in this sub-zone.

Sub-Zone III

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 met	40	5
1 Module 15 hyd	50	5
Sub-total:	557	443

Sub-Zone IV

3 Module 3 radars	1200	1200
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 met	40	5
Sub-total:	1345	1264

Sub-Zone V

5 Module 1 radars	1550	1550
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
2 Module 13 met	80	10
1 Module 15 hyd	50	5
2 Module 17 CCTV	26	20
Sub-total:	1811	1644

Sub-Zone VI

1 Module 10 VHF	19	13
1 Module 12 met	20	5
Sub-total:	39	18

Sub-Zone VII

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 met	40	5
Sub-total	417	348

Sub-Zone VIII

3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 met	40	5
Sub-total:	145	64

Sub-Zone IX

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 met	40	5
Sub-total:	369	328
HARDWARE TOTALS:	$9130	$6057

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$9130
Management, Engineering, etc. (75%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	6848
Installation site integration (25%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	2283
Spares & Training (10%)	913
Civil Engineering 12 remote radar sites,a VTC in New Orleans many remote comms and WX sensors installations, land acquisition	6000
PROJECT ESTIMATE:	25174
Data Base Management System	300
TOTAL: (non-recurring)	$25474

Recurring (10 year)

Hardware	6057
3 Watchstanders x 5 = 15 man/years @ 50K x 10	7500
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$17557
TOTAL 10-YEAR PROJECT COST:	$43031

REFERENCES

1. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico and Virgin Islands, 21st Ed. NOAA, Washington, DC, pp.49-50.

2. Ibid, pp. 61-63.

3. Final Report, National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, Oct. 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

AHP: Above Head of Passes

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix F Zone 6 New Orleans, LA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone	601A	
2060	A	MISSISSIPPI RIVER-GULF OUTLET, LA.
2235	A	BAYOU DUPRE, LA.
6032	A	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6904	A	PASSES OF THE MISSISSIPPI RIVER
Subzone	602E	
6032	A	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6032	B	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6904	A	PASSES OF THE MISSISSIPPI RIVER
6904	B	PASSES OF THE MISSISSIPPI RIVER
Subzone	603F	
2251	A	PORT OF NEW ORLEANS, LA.
6032	A	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6032	B	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
Subzone	604E	
2052	A	INNERHARBOR NAVIGATION CANAL, LA.*
2054	A	BAYOUS LA LOUTRE, ST. MALO, AND YSCLOSKEY, LA.
2060	A	MISSISSIPPI RIVER-GULF OUTLET, LA.
2235	A	BAYOU DUPRE, LA.
6241	A	GULF INTRACOASTAL WATERWAY, MOBILE BAY, ALA., TO
Subzone	605F	
2052	A	INNERHARBOR NAVIGATION CANAL, LA.*
2237	A	BAYOU SEGNETTE WATERWAY, LA.
2251	A	PORT OF NEW ORLEANS, LA.
6032	A	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6032	B	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES
6033	A	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.
6241	A	GULF INTRACOASTAL WATERWAY, MOBILE BAY, ALA., TO
6242	A	GULF INTRACOASTAL WATERWAY, MISSISSIPPI RIVER, LA., TO
Subzone	606F	
2252	A	PORT OF BATON ROUGE, LA.
6033	A	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.

Appendix F Zone 6 New Orleans, LA

TABLE 1 Assignment of COE Waterway Codes to Subzones 7/15/91

COE Waterway	Name
Subzone	605F
2052	INNERHARBOR NAVIGATION CANAL, LA.*(INCLUDED IN TRAFFIC OF PORT OF NEW ORLEANS)
2237	BAYOU SEGNETTE WATERWAY, LA.
2251	PORT OF NEW ORLEANS, LA.
6032	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES (INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)
6033	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.(INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)
6241	GULF INTRACOASTAL WATERWAY, MOBILE BAY, ALA., TO NEW ORLEANS, LA.* (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)
6242	GULF INTRACOASTAL WATERWAY, MISSISSIPPI RIVER, LA., TO SABINE RIVER, TEX.* (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)
Subzone	606F
2252	PORT OF BATON ROUGE, LA.
6033	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.(INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)

Appendix F Zone 6 New Orleans, LA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 601A Delta Appraoch

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	58,024,473	0	16,006,837	0	74,031,310
2	FOREST PRODUCTS	252,234	0	0	0	252,234
3	FISHERIES PRODUCTS	4,319	0	0	0	4,319
4	MINING PRODUCTS, NEC	27,379,913	0	23,641,760	0	51,021,673
5	PROC. FOODS & MFTRS, NEC	35,110,513	0	12,661,904	0	47,772,417
6	WASTE OF MANUFACTURING	1,436,052	0	659,285	0	2,095,337
1311	CRUDE PETROLEUM	0	28,524,433	0	12,637,260	41,161,693
1492	SULPHUR, DRY	15,070	0	447	0	15,517
1493	SULPHUR, LIQUID	0	1,843,327	0	2,099,772	3,943,099
2810	SODIUM HYDROXIDE (CAUSTI	235	0	648,406	0	648,641
2811	CRUDE PROD-COAL TAR-PET	14,417	0	34,814	0	49,231
2813	ALCOHOLS	0	505,793	0	495,659	1,001,452
2817	BENZENE AND TOLUENE	0	112,578	0	1,141,696	1,254,274
2818	SULPHURIC ACID	0	40	0	152,113	152,153
2871	NITROGEN CHEM FERTILIZER	17,857	1,504,996	0	375,469	1,898,322
2872	POTASSIC CHEM FERTILIZER	183,966	0	28,956	0	212,922
2873	PHOSPHA CHEM FERTILIZERS	174,181	0	74,742	0	248,923
2911	GASOLINE, INCL NATURAL	0	3,474,833	0	4,296,117	7,770,950
2912	JET FUEL	0	471,187	0	662,604	1,133,791
2913	KEROSENE	0	415,975	0	132,527	548,502
2914	DISTILLATE FUEL OIL	0	2,144,149	0	3,423,608	5,567,757
2915	RESIDUAL FUEL OIL	0	5,446,901	0	8,052,979	13,499,880
2916	LUBRIC OILS-GREASES	0	666,566	0	534,884	1,201,450
2917	NAPHTHA, PETRLM SOLVENTS	0	188,064	0	852,793	1,040,857
2921	LIQUI PETR-COAL-NATR GAS	0	473,118	0	1,312,709	1,785,827
	Subzone Total :	122,613,230	45,771,960	53,757,151	36,170,190	258,312,531

Subzone 602E Delta

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	57,502,455	0	15,987,507	0	73,489,962
2	FOREST PRODUCTS	225,159	0	0	0	225,159
3	FISHERIES PRODUCTS	478	0	0	0	478
4	MINING PRODUCTS, NEC	26,239,550	0	23,418,666	0	49,658,216
5	PROC. FOODS & MFTRS, NEC	31,426,988	0	12,051,665	0	43,478,653
6	WASTE OF MANUFACTURING	1,110,417	0	637,488	0	1,747,905
1311	CRUDE PETROLEUM	0	28,524,433	0	12,460,624	40,985,057
1492	SULPHUR, DRY	15,070	0	447	0	15,517
1493	SULPHUR, LIQUID	0	1,843,327	0	2,099,772	3,943,099
2810	SODIUM HYDROXIDE (CAUSTI	0	0	648,406	0	648,406
2811	CRUDE PROD-COAL TAR-PET	11,615	0	34,814	0	46,429
2813	ALCOHOLS	0	505,548	0	495,639	1,001,187
2817	BENZENE AND TOLUENE	0	112,578	0	1,141,693	1,254,271
2818	SULPHURIC ACID	0	0	0	151,993	151,993
2871	NITROGEN CHEM FERTILIZER	17,582	1,481,279	0	335,953	1,834,814
2872	POTASSIC CHEM FERTILIZER	11,183	0	27,948	0	39,131
2873	PHOSPHA CHEM FERTILIZERS	174,181	0	49,882	0	224,063
2911	GASOLINE, INCL NATURAL	0	3,420,174	0	4,169,820	7,589,994
2912	JET FUEL	0	471,187	0	662,604	1,133,791
2913	KEROSENE	0	415,975	0	132,527	548,502
2914	DISTILLATE FUEL OIL	0	2,144,149	0	3,422,910	5,567,059
2915	RESIDUAL FUEL OIL	0	5,446,901	0	8,029,880	13,476,781
2916	LUBRIC OILS-GREASES	0	666,509	0	534,580	1,201,089
2917	NAPHTHA, PETRLM SOLVENTS	0	188,064	0	852,780	1,040,844
2921	LIQUI PETR-COAL-NATR GAS	0	473,086	0	1,254,519	1,727,605
	Subzone Total :	116,734,678	45,693,210	52,856,823	35,745,294	251,030,005

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 603F Port of New Orleans

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	85,564,292	0	44,033,582	0	129,597,874
2	FOREST PRODUCTS	451,843	0	0	0	451,843
3	FISHERIES PRODUCTS	3,359	0	1	0	3,360
4	MINING PRODUCTS, NEC	39,181,451	0	37,894,588	0	77,076,039
5	PROC. FOODS & MFTRS, NEC	47,196,539	0	24,226,173	0	71,422,712
6	WASTE OF MANUFACTURING	1,408,072	0	763,275	0	2,171,347
1311	CRUDE PETROLEUM	0	37,561,537	0	20,503,704	58,065,241
1492	SULPHUR, DRY	31,308	0	1,172	0	32,480
1493	SULPHUR, LIQUID	0	3,541,114	0	4,271,829	7,812,943
2810	SODIUM HYDROXIDE (CAUSTI	189	0	728,056	0	728,245
2811	CRUDE PROD-COAL TAR-PET	33,823	0	69,080	0	102,903
2813	ALCOHOLS	0	675,805	0	717,566	1,393,371
2817	BENZENE AND TOLUENE	0	139,879	0	2,027,026	2,166,905
2818	SULPHURIC ACID	15	0	0	219,940	219,955
2871	NITROGEN CHEM FERTILIZER	35,163	1,663,219	0	389,852	2,088,234
2872	POTASSIC CHEM FERTILIZER	226,188	0	45,493	0	271,681
2873	PHOSPHA CHEM FERTILIZERS	240,460	0	291,787	0	532,247
2911	GASOLINE, INCL NATURAL	0	5,107,722	0	7,373,641	12,481,363
2912	JET FUEL	0	790,209	0	1,163,914	1,954,123
2913	KEROSENE	0	417,828	0	172,729	590,557
2914	DISTILLATE FUEL OIL	0	3,001,763	0	6,455,276	9,457,039
2915	RESIDUAL FUEL OIL	0	8,249,767	0	17,078,862	25,328,629
2916	LUBRIC OILS-GREASES	0	841,754	0	1,011,733	1,853,487
2917	NAPHTHA, PETRLM SOLVENTS	0	220,012	0	1,302,126	1,522,138
2921	LIQUI PETR-COAL-NATR GAS	0	555,278	0	2,074,148	2,629,426
	Subzone Total :	174,372,702	62,765,887	108,053,207	64,762,346	409,954,142

Subzone 604E Gulf Outlet Canal

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	999,758	0	426,238	0	1,425,996
2	FOREST PRODUCTS	54,1 0	0	0	0	54,150
3	FISHERIES PRODUCTS	7,682	0	0	0	7,682
4	MINING PRODUCTS, NEC	1,468,906	0	8,869,430	0	10,338,336
5	PROC. FOODS & MFTRS, NEC	6,416,090	0	4,809,382	0	11,225,472
6	WASTE OF MANUFACTURING	456,996	0	325,837	0	782,833
1311	CRUDE PETROLEUM	0	46	0	3,679,600	3,679,646
1493	SULPHUR, LIQUID	0	0	0	231,870	231,870
2810	SODIUM HYDROXIDE (CAUSTI	71,061	0	0	0	71,061
2811	CRUDE PROD-COAL TAR-PET	5,605	0	50,002	0	55,607
2813	ALCOHOLS	0	6,305	0	63,738	70,043
2817	BENZENE AND TOLUENE	0	685	0	137,040	137,725
2818	SULPHURIC ACID	40	667	0	125,010	125,717
2871	NITROGEN CHEM FERTILIZER	275	24,000	0	154,508	178,783
2872	POTASSIC CHEM FERTILIZER	181,071	0	2,472	0	183,543
2873	PHOSPHA CHEM FERTILIZERS	0	0	54,012	0	54,012
2911	GASOLINE, INCL NATURAL	0	389,265	0	2,684,120	3,073,385
2912	JET FUEL	0	0	0	552,773	552,773
2913	KEROSENE	0	0	0	35,073	35,073
2914	DISTILLATE FUEL OIL	0	340,587	0	995,796	1,336,383
2915	RESIDUAL FUEL OIL	0	13,314	0	1,347,488	1,360,802
2916	LUBRIC OILS-GREASES	0	67,725	0	104,284	172,009
2917	NAPHTHA, PETRLM SOLVENTS	0	3,057	0	346,474	349,531
2921	LIQUI PETR-COAL-NATR GAS	33	8,266	0	364,953	373,252
	Subzone Total :	9,661,667	853,917	14,537,373	10,822,727	35,875,684

TABLE 2   Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 605F   River Passes to New Orleans

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	129,395,559	0	98,227,304	0	227,622,863
2	FOREST PRODUCTS	479,873	0	0	0	479,873
3	FISHERIES PRODUCTS	7,253	0	1	C	7,254
4	MINING PRODUCTS, NEC	53,684,528	0	83,390,235	0	137,074,763
5	PROC. FOODS & MFTRS, NEC	73,508,340	0	79,127,184	0	152,635,524
6	WASTE OF MANUFACTURING	2,491,723	0	4,007,340	0	6,499,063
1311	CRUDE PETROLEUM	0	58,557,045	0	46,587,608	105,144,653
1492	SULPHUR, DRY	31,359	0	1,172	0	32,531
1493	SULPHUR, LIQUID	0	3,541,114	0	5,475,003	9,016,117
2810	SODIUM HYDROXIDE (CAUSTI	71,015	0	1,235,754	0	1,306,769
2811	CRUDE PROD-COAL TAR-PET	39,973	0	232,407	0	272,380
2813	ALCOHOLS	0	1,049,259	0	3,634,832	4,684,091
2817	BENZENE AND TOLUENE	0	226,936	0	6,712,227	6,939,163
2818	SULPHURIC ACID	55	627	0	690,752	691,434
2871	NITROGEN CHEM FERTILIZER	35,163	2,874,481	0	2,585,811	5,495,455
2872	POTASSIC CHEM FERTILIZER	439,423	0	220,692	0	660,115
2873	PHOSPHA CHEM FERTILIZERS	404,912	0	328,893	0	733,805
2911	GASOLINE, INCL NATURAL	0	8,564,750	0	21,255,865	29,820,615
2912	JET FUEL	0	1,203,783	0	3,296,754	4,500,537
2913	KEROSENE	0	829,184	0	730,722	1,559,906
2914	DISTILLATE FUEL OIL	0	4,869,134	0	15,789,711	20,658,845
2915	RESIDUAL FUEL OIL	0	12,586,712	0	33,201,476	45,788,188
2916	LUBRIC OILS-GREASES	0	1,495,143	0	3,948,438	5,443,581
2917	NAPHTHA, PETRLM SOLVENTS	0	377,721	0	5,159,012	5,536,733
2921	LIQUI PETR-COAL-NATR GAS	33	842,073	0	3,325,799	4,167,905
	Subzone Total :	260,589,209	97,017,962	266,770,982	152,394,010	776,772,163

Subzone 606F   River New Orleans to Baton Rou

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	45,748,526	0	53,689,863	0	99,438,389
2	FOREST PRODUCTS	1,263	0	0	0	1,263
3	FISHERIES PRODUCTS	60	0	0	0	60
4	MINING PRODUCTS, NEC	20,506,858	0	38,702,283	0	59,209,141
5	PROC. FOODS & MFTRS, NEC	32,914,673	0	47,227,045	0	80,141,718
6	WASTE OF MANUFACTURING	1,376,567	0	2,398,411	0	3,774,978
1311	CRUDE PETROLEUM	0	29,205,865	0	8,869,308	38,075,173
1492	SULPHUR, DRY	102	0	0	0	102
1493	SULPHUR, LIQUID	0	0	0	700,351	700,351
2810	SODIUM HYDROXIDE (CAUSTI	0	0	659,355	0	659,355
2811	CRUDE PROD-COAL TAR-PET	3,347	0	100,795	0	104,142
2813	ALCOHOLS	0	644,973	0	2,885,439	3,530,412
2817	BENZENE AND TOLUENE	0	168,543	0	4,127,274	4,295,817
2818	SULPHURIC ACID	0	0	0	1,003,717	1,003,717
2871	NITROGEN CHEM FERTILIZER	0	2,484,899	0	3,154,733	5,639,632
2872	POTASSIC CHEM FERTILIZER	369,919	0	57,874	0	427,793
2873	PHOSPHA CHEM FERTILIZERS	333,978	0	13,952	0	347,930
2911	GASOLINE, INCL NATURAL	0	3,637,944	0	10,527,273	14,165,217
2912	JET FUEL	0	546,991	0	1,709,554	2,256,545
2913	KEROSENE	0	806,854	0	177,595	984,449
2914	DISTILLATE FUEL OIL	0	2,334,705	0	6,335,993	8,670,698
2915	RESIDUAL FUEL OIL	0	5,577,035	0	12,650,583	18,227,618
2916	LUBRIC OILS-GREASES	0	1,164,982	0	1,640,976	2,805,958
2917	NAPHTHA, PETRLM SOLVENTS	0	284,436	0	2,499,895	2,784,331
2921	LIQUI PETR-COAL-NATR GAS	0	383,096	0	297,229	680,325
	Subzone Total :	101,255,293	47,240,323	142,849,578	56,579,920	347,925,114

Appendix F ZONE 6 New Orleans, LA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 601A				
Passenger	0	52	73,000	73,052
Dry Cargo	5,403	9,478	20,499	35,380
Tanker	3,065	3,322	543	6,930
Dry Cargo Barge Tow	706	0	579	1,285
Tanker Barge Tow	1,154	0	307	1,461
Tug/Tow Boat	1,712	0	0	1,712
Subzone Total:	12,040	12,852	94,928	119,820
Subzone : 602E				
Passenger	0	52	18,250	18,302
Dry Cargo	5,182	8,436	20,159	33,777
Tanker	3,065	3,322	541	6,928
Dry Cargo Barge Tow	705	0	4,003	4,708
Tanker Barge Tow	1,154	0	9,280	10,434
Tug/Tow Boat	1,709	0	17,655	19,365
Subzone Total:	11,815	11,810	69,888	93,513
Subzone : 603F				
Passenger	C	52	238,651	238,703
Dry Cargo	4,032	7,182	23,964	35,178
Tanker	2,151	2,415	425	4,991
Dry Cargo Barge Tow	78	0	9,505	9,584
Tanker Barge Tow	436	0	14,607	15,043
Tug/Tow Boat	2,942	0	27,178	30,120
Subzone Total:	9,640	9,649	314,330	333,619
Subzone : 604E				
Passenger	0	0	3,920	3,920
Dry Cargo	221	2,116	692	3,029
Tanker	0	0	7	7
Dry Cargo Barge Tow	2	0	5,032	5,034
Tanker Barge Tow	0	0	3,467	3,467
Tug/Tow Boat	5	0	4,342	4,347
Subzone Total:	228	2,116	17,460	19,804

Appendix F ZONE 6 New Orleans, LA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 605F				
Passenger	0	52	0	52
Dry Cargo	7,088	9,879	36,430	53,397
Tanker	3,324	3,615	638	7,577
Dry Cargo Barge Tow	89	0	25,670	25,759
Tanker Barge Tow	666	0	42,093	42,758
Tug/Tow Boat	2,930	0	55,388	58,318
Subzone Total:	14,096	13,546	160,219	187,861
Subzone : 606F				
Dry Cargo	3,526	2,276	2,926	8,728
Tanker	1,712	1,832	296	3,840
Dry Cargo Barge Tow	14	0	6,340	6,354
Tanker Barge Tow	236	0	15,265	15,500
Tug/Tow Boat	50	0	18,134	18,184
Subzone Total:	5,537	4,108	42,961	52,606

Note: Sum of all vessel transits within each study subzone.

ZONE TOTALS

ZONE 6 New Orleans, LA

Vessel Type	Large	Medium	Small	Total
Passenger	0	52	216,751	216,803
Dry Cargo	10,358	15,800	42,024	68,182
Tanker	5,390	5,901	1,005	12,296
Dry Cargo Barge Tow	771	0	28,582	29,353
Tanker Barge Tow	1,594	0	48,020	49,613
Tug/Tow Boat	3,169	0	62,360	65,529
Zone Total:	21,282	21,753	398,742	441,777

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix F ZONE 6 New Orleans, LA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 601A Delta Appraoch		
2060	MISSISSIPPI RIVER-GULF OUTLET, LA.	3	3
6032	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES (INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)	25	4
	SUBZONE 602E Delta		
6032	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES (INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)	25	4
	SUBZONE 603F Port of New Orleans		
2251	PORT OF NEW ORLEANS, LA.	10	4
6032	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES (INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)	25	4
	SUBZONE 604E Gulf Outlet Canal		
2052	INNERHARBOR NAVIGATION CANAL, LA.*(INCLUDED IN TRAFFIC OF PORT OF NEW ORLEANS)	10	4
2060	MISSISSIPPI RIVER-GULF OUTLET, LA.	3	3
6241	GULF INTRACOASTAL WATERWAY, MOBILE BAY, ALA., TO NEW ORLEANS, LA.* (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 605F River Passes to New Orleans		
2052	INNERHARBOR NAVIGATION CANAL, LA.*(INCLUDED IN TRAFFIC OF PORT OF NEW ORLEANS)	10	4
2251	PORT OF NEW ORLEANS, LA.	10	4
6032	MISSISSIPPI RIVER, NEW ORLEANS, LA., TO MOUTH OF PASSES (INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF PASSES)	25	4
6033	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.(INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF	25	4
6[illegible]	GULF INTRACOASTAL WATERWAY, MOBILE BAY, ALA., TO NEW ORLEANS, LA.* (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
6242	GULF INTRACOASTAL WATERWAY, MISSISSIPPI RIVER, LA., TO SABINE RIVER, TEX.* (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED	3	3
	SUBZONE 606F River New Orleans to Baton Rou		
2252	PORT OF BATON ROUGE, LA.	25	4
6033	MISSISSIPPI RIVER, BATON ROUGE, LA., TO NEW ORLEANS, LA.(INCLUDED IN TRAFFIC OF MISSISSIPPI RIVER, MINNEAPOLIS TO MOUTH OF	25	4

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix F Zone 6 New Orleans, LA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
601A	Delta Appraoch	2,505	1.01
602E	Delta	1,228	10.23
603F	Port of New Orleans	13,490	391.01
604E	Gulf Outlet Canal	5,601	400.07
605F	River Passes to New Orleans	19,479	769.92
606F	River New Orleans to Baton Rou	37,199	673.89
	Total for Zone	79,502	29.24

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

7/24/91

Appendix F ZONE 6 New Orleans, LA

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 601A				
Passenger	0	55	0	55
Dry Cargo	6,353	11,034	26,270	43,657
Tanker	3,276	3,309	552	7,137
Dry Cargo Tow	714	0	5,052	5,766
Tanker Tow	1,101	0	9,620	10,720
Tug/Tow Boat	0	0	25,012	25,012
Subzone Total:	11,444	14,398	66,506	92,347
Subzone : 602E				
Passenger	0	55	0	55
Dry Cargo	6,082	9,736	25,834	41,652
Tanker	3,276	3,309	550	7,135
Dry Cargo Tow	714	0	4,384	5,098
Tanker Tow	1,101	0	9,302	10,402
Tug/Tow Boat	0	0	25,162	25,162
Subzone Total:	11,173	13,100	65,232	89,504
Subzone : 603F				
Passenger	0	55	4,217	4,271
Dry Cargo	5,383	9,285	32,283	46,951
Tanker	2,459	2,458	455	5,372
Dry Cargo Tow	104	0	10,859	10,963
Tanker Tow	421	0	14,643	15,064
Tug/Tow Boat	0	0	37,103	37,103
Subzone Total:	8,367	11,798	99,560	119,725
Subzone : 604E				
Passenger	0	0	4,126	4,126
Dry Cargo	271	2,687	910	3,868
Tanker	0	0	7	7
Dry Cargo Tow	0	0	5,813	5,813
Tanker Tow	0	0	3,550	3,550
Tug/Tow Boat	0	0	2,552	2,552
Subzone Total:	271	2,687	16,958	19,916

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 605F				
Passenger	0	55	149,951	150,006
Dry Cargo	9,435	12,896	49,306	71,637
Tanker	3,745	3,591	667	8,003
Dry Cargo Tow	111	0	29,421	29,532
Tanker Tow	640	0	42,687	43,327
Tug/Tow Boat	0	0	53,796	53,796
Subzone Total:	13,931	16,542	325,828	356,301
Subzone : 606F				
Passenger	0	0	78,285	78,285
Dry Cargo	4,683	3,104	4,152	11,939
Tanker	1,859	1,749	294	3,902
Dry Cargo Tow	9	0	7,215	7,224
Tanker Tow	225	0	15,626	15,852
Tug/Tow Boat	0	0	21,899	21,899
Subzone Total:	6,776	4,853	127,472	139,101

Note: Sum of all vessel transits within each study subzone.

Appendix F ZONE 6 New Orleans, LA 7/24/91

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 601A				
Passenger	0	58	0	58
Dry Cargo	7,137	12,237	30,734	50,108
Tanker	3,494	3,459	588	7,541
Dry Cargo Tow	722	0	5,387	6,109
Tanker Tow	1,113	0	9,831	10,944
Tug/Tow Boat	0	0	28,481	28,481
Subzone Total:	12,465	15,754	75,021	103,240
Subzone : 602E				
Passenger	0	58	0	58
Dry Cargo	6,824	10,734	30,221	47,779
Tanker	3,494	3,459	585	7,538
Dry Cargo Tow	722	0	4,655	5,377
Tanker Tow	1,113	0	9,502	10,615
Tug/Tow Boat	0	0	28,599	28,599
Subzone Total:	12,152	14,251	73,562	99,965
Subzone : 603F				
Passenger	0	58	4,438	4,496
Dry Cargo	6,493	10,884	38,754	56,131
Tanker	2,775	2,718	521	6,014
Dry Cargo Tow	125	0	11,816	11,940
Tanker Tow	442	0	15,028	15,470
Tug/Tow Boat	0	0	42,724	42,724
Subzone Total:	9,835	13,660	113,280	136,775
Subzone : 604E				
Passenger	0	0	4,343	4,343
Dry Cargo	313	3,151	1,071	4,535
Tanker	0	0	9	9
Dry Cargo Tow	0	0	6,383	6,383
Tanker Tow	0	0	3,655	3,655
Tug/Tow Boat	0	0	3,084	3,084
Subzone Total:	313	3,151	18,544	22,008

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 605F				
Passenger	0	58	157,835	157,892
Dry Cargo	11,361	15,186	59,499	86,046
Tanker	4,195	3,924	755	8,874
Dry Cargo Tow	132	0	32,092	32,224
Tanker Tow	669	0	43,967	44,637
Tug/Tow Boat	0	0	62,048	62,048
Subzone Total:	16,358	19,168	356,196	391,721
Subzone : 606F				
Passenger	0	0	82,401	82,401
Dry Cargo	5,633	3,715	5,066	14,414
Tanker	2,039	1,862	320	4,221
Dry Cargo Tow	10	0	7,835	7,845
Tanker Tow	234	0	16,253	16,487
Tug/Tow Boat	0	0	25,181	25,181
Subzone Total:	7,916	5,577	137,056	150,549

Note: Sum of all vessel transits within each study subzone.

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 601A				
Passenger	0	60	0	60
Dry Cargo	8,104	13,809	36,562	58,475
Tanker	3,759	3,656	636	8,051
Dry Cargo Tow	731	0	5,755	6,486
Tanker Tow	1,126	0	10,031	11,157
Tug/Tow Boat	0	0	32,768	32,768
Subzone Total:	13,719	17,525	85,752	116,996
Subzone : 602E				
Passenger	0	60	0	60
Dry Cargo	7,731	12,029	35,952	55,712
Tanker	3,759	3,656	633	8,048
Dry Cargo Tow	731	0	4,954	5,685
Tanker Tow	1,126	0	9,690	10,816
Tug/Tow Boat	0	0	32,835	32,835
Subzone Total:	13,346	15,745	84,064	113,155
Subzone : 603F				
Passenger	0	60	4,594	4,653
Dry Cargo	7,846	12,941	47,156	67,943
Tanker	3,156	3,055	609	6,820
Dry Cargo Tow	149	0	12,864	13,014
Tanker Tow	463	0	15,385	15,849
Tug/Tow Boat	0	0	49,646	49,646
Subzone Total:	11,615	16,056	130,255	157,925
Subzone : 604E				
Passenger	0	0	4,495	4,495
Dry Cargo	373	3,750	1,269	5,392
Tanker	0	0	9	9
Dry Cargo Tow	0	0	7,010	7,010
Tanker Tow	0	0	3,759	3,759
Tug/Tow Boat	0	0	3,758	3,758
Subzone Total:	373	3,750	20,300	24,423

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 605F				
Passenger	0	60	163,356	163,415
Dry Cargo	13,703	18,177	72,672	104,552
Tanker	4,738	4,357	870	9,965
Dry Cargo Tow	158	0	35,020	35,178
Tanker Tow	699	0	45,211	45,910
Tug/Tow Boat	0	0	72,294	72,294
Subzone Total:	19,298	22,594	389,423	431,314
Subzone : 606F				
Passenger	0	0	85,283	85,283
Dry Cargo	6,790	4,565	6,319	17,674
Tanker	2,257	2,009	354	4,620
Dry Cargo Tow	12	0	8,511	8,522
Tanker Tow	243	0	16,864	17,107
Tug/Tow Boat	0	0	29,352	29,352
Subzone Total:	9,302	6,574	146,682	162,558

Note: Sum of all vessel transits within each study subzone.

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 601A				
Passenger	0	62	0	62
Dry Cargo	9,295	15,806	44,007	69,108
Tanker	4,094	3,905	696	8,695
Dry Cargo Tow	742	0	6,162	6,903
Tanker Tow	1,143	0	10,261	11,404
Tug/Tow Boat	0	0	38,062	38,062
Subzone Total:	15,274	19,773	99,187	134,233
Subzone : 602E				
Passenger	0	62	0	62
Dry Cargo	8,849	13,650	43,275	65,774
Tanker	4,094	3,905	693	8,692
Dry Cargo Tow	742	0	5,284	6,026
Tanker Tow	1,143	0	9,907	11,050
Tug/Tow Boat	0	0	38,055	38,055
Subzone Total:	14,828	17,617	97,214	129,658
Subzone : 603F				
Passenger	0	62	4,754	4,816
Dry Cargo	9,511	15,499	57,874	82,884
Tanker	3,637	3,477	720	7,834
Dry Cargo Tow	180	0	14,016	14,196
Tanker Tow	491	0	15,795	16,285
Tug/Tow Boat	0	0	58,169	58,169
Subzone Total:	13,818	19,038	151,328	184,184
Subzone : 604E				
Passenger	0	0	4,652	4,652
Dry Cargo	446	4,530	1,518	6,494
Tanker	0	0	9	9
Dry Cargo Tow	0	0	7,705	7,705
Tanker Tow	0	0	3,875	3,875
Tug/Tow Boat	0	0	4,612	4,612
Subzone Total:	446	4,530	22,371	27,347

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Appendix F ZONE 6 New Orleans, LA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 605F				
Passenger	0	62	169,070	169,131
Dry Cargo	16,578	21,944	89,500	128,022
Tanker	5,426	4,903	1,017	11,346
Dry Cargo Tow	190	0	38,239	38,429
Tanker Tow	737	0	46,610	47,347
Tug/Tow Boat	0	0	85,013	85,013
Subzone Total:	22,931	26,909	429,449	479,289
Subzone : 606F				
Passenger	0	0	88,266	88,266
Dry Cargo	8,209	5,676	8,000	21,885
Tanker	2,536	2,201	399	5,136
Dry Cargo Tow	13	0	9,251	9,264
Tanker Tow	255	0	17,543	17,798
Tug/Tow Boat	0	0	34,643	34,643
Subzone Total:	11,014	7,877	158,101	176,992

Note: Sum of all vessel transits within each study subzone.

Appendix F ZONE 6 New Orleans, LA 7/25/91

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	55	228,146	228,201
Dry Cargo	11,945	17,996	51,109	81,050
Tanker	5,845	5,861	1,034	12,740
Dry Cargo Tow	790	0	32,557	33,347
Tanker Tow	1,528	0	48,794	50,321
Tug/Tow Boat	0	0	63,797	63,797
1995 Zone Total:	20,107	23,912	425,436	469,455
2000 FORECASTED ZONE TOTALS				
Passenger	0	58	240,140	240,198
Dry Cargo	13,184	19,556	57,843	90,583
Tanker	6,341	6,234	1,129	13,704
Dry Cargo Tow	812	0	35,386	36,198
Tanker Tow	1,557	0	50,296	51,854
Tug/Tow Boat	0	0	73,230	73,230
2000 Zone Total:	21,894	25,848	458,025	505,767
2005 FORECASTED ZONE TOTALS				
Passenger	0	60	248,540	248,600
Dry Cargo	15,375	22,052	67,926	105,353
Tanker	6,940	6,718	1,252	14,910
Dry Cargo Tow	838	0	38,490	39,328
Tanker Tow	1,587	0	51,763	53,350
Tug/Tow Boat	0	0	84,996	84,996
2005 Zone Total:	24,740	28,830	492,967	546,537
2010 FORECASTED ZONE TOTALS				
Passenger	0	62	257,234	257,296
Dry Cargo	18,067	25,783	82,745	126,595
Tanker	7,700	7,332	1,409	16,441
Dry Cargo Tow	870	0	41,901	42,772
Tanker Tow	1,627	0	53,408	55,035
Tug/Tow Boat	0	0	99,665	99,665
2010 Zone Total:	28,264	33,177	536,363	597,804

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 601A Delta Appraoch						
Passenger	Medium	0	0	1	0	1
Passenger	Small	1	1	2	0	4
Dry Cargo	Large	1	1	13	0	15
Dry Cargo	Medium	1	0	1	0	2
Dry Cargo	Small	3	0	0	0	3
Tanker	Large	0	0	1	0	1
Tanker	Medium	1	0	0	0	1
Dry Cargo Barge Tow	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	2	0	2	1	5
Tanker Barge Tow	Large	0	1	0	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Tug/Tow Boat	Small	1	1	2	0	4
Fishing	Small	4	0	1	0	5
Other	Small	3	0	0	0	3
Subzone Totals:		18	4	24	1	47
Subzone: 602E Delta						
Passenger	Small	2	0	2	0	4
Dry Cargo	Large	5	0	14	0	19
Dry Cargo	Medium	0	1	0	0	1
Dry Cargo	Small	1	0	0	0	1
Tanker	Large	3	0	8	0	11
Dry Cargo Barge Tow	Small	5	0	0	0	5
Tanker Barge Tow	Small	0	0	1	0	1
Tug/Tow Boat	Small	2	0	0	0	2
Fishing	Small	1	0	0	0	1
Other	Small	6	0	2	0	8
Subzone Totals:		25	1	27	0	53
Subzone: 603F Port of New Orleans						
Passenger	Small	6	0	0	0	6
Dry Cargo	Large	3	0	22	1	26
Dry Cargo	Medium	4	0	2	0	6
Dry Cargo	Small	2	0	0	0	2
Tanker	Large	3	0	18	0	21
Dry Cargo Barge Tow	Large	1	0	1	1	3
Dry Cargo Barge Tow	Small	5	1	0	1	7
Tanker Barge Tow	Small	2	0	3	0	5
Tug/Tow Boat	Small	1	0	3	0	4
Fishing	Small	2	0	0	0	2
Other	Small	11	0	0	0	11
Subzone Totals:		40	1	49	3	93

Note: OTHER equals barge breakaways and weather caused vessel casualties.

Appendix F Zone 6 New Orleans, LA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 604E Gulf Outlet Canal						
Passenger	Small	0	0	1	0	1
Dry Cargo	Large	0	0	7	0	7
Dry Cargo	Medium	2	0	3	0	5
Tug/Tow Boat	Small	1	1	0	0	2
Fishing	Small	1	0	0	0	1
Other	Small	1	0	0	0	1
Subzone Totals:		5	1	11	0	17
Subzone: 605F River Passes to New Orleans						
Passenger	Small	3	1	0	1	5
Dry Cargo	Large	6	1	3	0	10
Dry Cargo	Medium	4	1	0	0	5
Dry Cargo	Small	2	0	0	0	2
Tanker	Large	4	3	3	0	10
Dry Cargo Barge Tow	Large	2	0	0	0	2
Dry Cargo Barge Tow	Small	19	10	5	3	37
Tanker Barge Tow	Small	23	6	3	2	34
Tug/Tow Boat	Small	6	0	2	0	8
Fishing	Small	1	1	0	0	2
Other	Small	1	1	1	1	4
Subzone Totals:		71	24	17	7	119
Subzone: 606F River New Orleans to Baton Rou						
Passenger	Medium	1	0	0	0	1
Passenger	Small	1	3	0	0	4
Dry Cargo	Large	8	0	10	0	18
Dry Cargo	Medium	2	1	0	0	3
Dry Cargo	Small	0	0	0	2	2
Tanker	Large	9	1	24	1	35
Tanker	Medium	0	1	0	0	1
Tanker	Small	1	0	1	0	2
Dry Cargo Barge Tow	Large	1	0	1	0	2
Dry Cargo Barge Tow	Small	36	1	8	5	50
Tanker Barge Tow	Small	23	3	10	1	37
Tug/Tow Boat	Small	7	1	5	1	14
Other	Small	1	0	0	0	1
Subzone Totals:		90	11	59	10	170
Zone Totals:		249	42	187	21	499

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE F-8 ZONE 6, NEW ORLEANS, LA - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0601A																	III
0602E	I	I		I	I	I	I	I	I	I							III
0603F	I	I		I	I	I	I	I	I	I							III
0604E	I	I		I	I	I	I	I	I	I							III
0605F	I	I		I	I	I	I	I	I	I							III
0606F	I	I		I	I	I	I	I	I	I							I

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

APPENDIX TABLE F-9 ZONE 6, NEW ORLEANS, LA - CANDIDATE VTS DESIGN - 1995-2010

UNITS

7	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
5	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
14	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
6	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
8	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
3	Hydrological Module 15	- Water Temperature, Depth and Current
1	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
2	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix F Zone 6 New Orleans, LA

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.27	0.00	.27	.54
Passenger	Small	14.08	2.04	12.00	28.12
Dry Cargo	Large	19.73	3.50	21.60	44.82
Dry Cargo	Medium	12.35	1.95	4.40	18.70
Dry Cargo	Small	12.11	1.37	1.83	15.31
Tanker	Large	17.85	4.28	22.01	44.14
Tanker	Medium	2.11	.20	1.16	3.48
Tanker	Small	.17	0.00	.12	.29
Dry Cargo Barge T	Large	4.58	0.00	3.79	8.38
Dry Cargo Barge T	Small	51.14	16.27	16.31	83.71
Tanker Barge Tow	Large	1.44	.69	.86	2.99
Tanker Barge Tow	Small	68.69	13.31	36.10	118.11
Tug/Tow Boat	Small	8.94	2.98	5.31	17.23
		213.47	46.58	125.76	385.80

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	470	0	297	767
Passenger	Small	12,498	1,789	7,594	21,882
Dry Cargo	Large	26,732	6,178	6,702	39,612
Dry Cargo	Medium	18,166	3,651	1,313	23,130
Dry Cargo	Small	8,418	969	1,132	10,520
Tanker	Large	103,132	25,099	70,254	198,485
Tanker	Medium	4,169	442	790	5,401
Tanker	Small	154	0	29	183
Dry Cargo Barge T	Large	520	0	75	595
Dry Cargo Barge T	Small	2,865	2,505	264	5,634
Tanker Barge Tow	Large	17,912	8,415	6,652	32,980
Tanker Barge Tow	Small	270,066	49,985	15,541	335,593
Tug/Tow Boat	Small	691	466	393	1,550
		465,794	99,500	111,036	676,330

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.03	0.00	.03	.07
Passenger	Small	.90	.13	.77	1.80
Dry Cargo	Large	2.46	.44	2.65	5.55
Dry Cargo	Medium	1.53	.24	.55	2.33
Dry Cargo	Small	.77	.09	.12	.98
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.11	.04	.04	.18
Tanker Barge Tow	Small	.15	.03	.08	.26
Tug/Tow Boat	Small	.02	.01	.01	.04
Totals		5.98	.97	4.25	11.20
Candidate VTS Design - Dollars					
Passenger	Medium	51,170.09	0.00	50,949.62	102,119.70
Passenger	Small	1,351,750.42	195,622.76	1,152,522.86	2,699,896.05
Dry Cargo	Large	3,690,330.12	657,729.14	3,976,999.57	8,325,058.83
Dry Cargo	Medium	2,295,732.30	366,445.43	827,120.39	3,489,298.12
Dry Cargo	Small	1,162,128.92	131,320.29	175,520.76	1,468,969.97
Tanker	Small	557.13	0.00	370.38	927.51
Dry Cargo Barge Tow	Small	167,933.62	52,530.38	53,911.98	274,375.98
Tanker Barge Tow	Small	227,099.90	44,015.86	117,592.27	388,708.03
Tug/Tow Boat	Small	28,791.07	9,817.52	17,532.49	56,141.08
Totals		8,975,493.56	1,457,481.38	6,372,520.32	16,805,495.26

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.01
Passenger	Small	10.69	1.55	9.11	21.34
Dry Cargo	Large	.27	.05	.29	.60
Dry Cargo	Medium	.17	.03	.06	.25
Dry Cargo	Small	9.19	1.04	1.39	11.61
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	1.24	.39	.40	2.02
Tanker Barge Tow	Small	1.67	.32	.86	2.85
Tug/Tow Boat	Small	.21	.07	.13	.41
Totals		23.43	3.44	12.24	39.10
Candidate VTS Design - Dollars					
Passenger	Medium	878.35	0.00	874.76	1,753.11
Passenger	Small	2,545,368.47	368,360.91	2,170,219.68	5,083,949.06
Dry Cargo	Large	63,475.08	10,901.30	69,295.63	143,672.01
Dry Cargo	Medium	39,753.31	6,269.65	14,038.98	60,061.93
Dry Cargo	Small	2,188,102.56	247,278.29	330,508.50	2,765,889.35
Tanker	Small	973.97	0.00	639.59	1,613.57
Dry Cargo Barge Tow	Small	294,916.47	91,787.07	94,200.66	480,904.20
Tanker Barge Tow	Small	396,815.05	76,512.93	205,470.63	678,798.61
Tug/Tow Boat	Small	50,231.66	17,154.05	30,635.14	98,020.84
Totals		5,580,514.93	818,264.18	2,915,883.58	9,314,662.68

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.20	0.00	.12	.32
Passenger	Small	12.01	1.36	3.78	17.14
Dry Cargo	Large	14.40	2.40	2.11	18.91
Dry Cargo	Medium	9.05	1.37	.43	10.84
Dry Cargo	Small	10.37	.95	.96	12.28
Tanker	Large	13.48	3.42	2.89	19.79
Tanker	Medium	1.56	.16	.15	1.87
Tanker	Small	.04	0.00	.02	.06
Dry Cargo Barge Tow	Large	4.03	0.00	.73	4.77
Dry Cargo Barge Tow	Small	39.02	6.78	2.26	48.06
Tanker Barge Tow	Large	1.31	.34	.17	1.82
Tanker Barge Tow	Small	52.42	5.63	4.97	63.01
Tug/Tow Boat	Small	1.53	.34	.66	2.53
Totals		159.43	22.74	19.24	201.40
Candidate VTS Design - Dollars					
Passenger	Medium	176,038.06	0.00	101,143.48	277,181.54
Passenger	Small	4,089,559.52	462,585.31	1,932,021.36	6,484,166.19
Dry Cargo	Large	10,620,132.04	1,769,472.39	1,251,241.30	13,640,845.73
Dry Cargo	Medium	8,061,296.10	1,217,557.37	188,862.35	9,467,715.82
Dry Cargo	Small	1,966,982.62	180,869.64	245,794.98	2,393,647.24
Tanker	Large	10,595,412.71	2,689,274.63	6,215,123.08	19,499,810.42
Tanker	Medium	1,030,172.83	105,545.04	263,928.20	1,399,646.07
Tanker	Small	11,041.25	0.00	9,424.44	20,465.69
Dry Cargo Barge Tow	Large	520,096.88	0.00	74,874.42	594,971.31
Dry Cargo Barge Tow	Small	2,265,762.63	391,516.01	115,227.31	2,772,505.96
Tanker Barge Tow	Large	212,365.77	55,858.74	33,934.54	302,159.05
Tanker Barge Tow	Small	3,718,544.21	399,077.44	447,478.97	4,565,100.62
Tug/Tow Boat	Small	109,852.53	24,107.54	65,183.00	199,143.06
Totals		43,377,257.15	7,295,864.11	10,944,237.43	61,617,358.69

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.05	0.00	.02	.07
Passenger	Small	3.17	.38	1.05	4.60
Dry Cargo	Large	5.94	1.32	2.76	10.02
Dry Cargo	Medium	3.74	.74	.55	5.03
Dry Cargo	Small	4.70	.49	.42	5.61
Tanker	Large	5.50	1.37	2.94	9.82
Tanker	Medium	.64	.06	.15	.86
Tanker	Small	.04	0.00	.02	.06
Dry Cargo Tow	Large	.51	0.00	.40	.92
Dry Cargo Tow	Small	10.80	3.36	1.40	15.55
Tanker Tow	Large	.17	.08	.09	.34
Tanker Tow	Small	14.51	2.79	3.08	20.38
Tug/Tow Boat	Small	.75	.22	.18	1.14
Totals		50.53	10.80	13.06	74.39
Candidate VTS Design - Dollars					
Passenger	Medium	769.72	0.00	316.76	1,086.48
Passenger	Small	10,342.20	1,169.82	4,363.21	15,875.22
Dry Cargo	Large	54,678.07	13,911.33	5,749.76	74,339.17
Dry Cargo	Medium	34,354.49	7,681.73	1,157.11	43,193.33
Dry Cargo	Small	8,935.27	821.99	1,103.44	10,860.70
Tanker	Large	224,828.10	52,430.21	207,316.91	484,575.23
Tanker	Medium	8,268.18	828.65	1,594.57	10,691.40
Tanker	Small	155.99	0.00	61.35	217.34
Tanker Tow	Large	85,378.94	38,088.87	45,539.79	169,007.60
Tanker Tow	Small	852,282.03	161,365.71	183,681.60	1,197,329.34
Tug/Tow Boat	Small	1,322.35	290.17	763.74	2,376.26
Totals		1,281,315.35	276,588.48	451,648.25	2,009,552.08

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.23	.07	.30
Dry Cargo	Large	0.00	.39	.12	.51
Dry Cargo	Medium	0.00	.22	.02	.24
Dry Cargo	Small	0.00	.16	.01	.17
Tanker	Large	0.00	.49	.13	.61
Tanker	Medium	0.00	.02	.01	.03
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.02	.02
Dry Cargo Barge Tow	Small	0.00	1.82	.09	1.91
Tanker Barge Tow	Large	0.00	.08	.00	.08
Tanker Barge Tow	Small	0.00	1.51	.21	1.71
Tug/Tow Boat	Small	0.00	.34	.03	.37
Totals		0.00	5.25	.71	5.97
Candidate VTS Design - Dollars					
Passenger	Small	0.00	1,315.18	387.90	1,703.08
Dry Cargo	Large	0.00	2,216.46	698.04	2,914.49
Dry Cargo	Medium	0.00	1,243.40	140.39	1,383.78
Dry Cargo	Small	0.00	883.93	59.00	942.93
Tanker	Large	0.00	2,760.83	711.34	3,472.17
Tanker	Medium	0.00	129.68	36.55	166.23
Tanker	Small	0.00	0.00	3.56	3.56
Dry Cargo Barge Tow	Large	0.00	0.00	119.22	119.22
Dry Cargo Barge Tow	Small	0.00	10,258.42	522.04	10,780.46
Tanker Barge Tow	Large	0.00	444.60	27.83	472.43
Tanker Barge Tow	Small	0.00	8,517.37	1,158.19	9,675.56
Tug/Tow Boat	Small	0.00	1,917.12	171.49	2,088.61
Totals		0.00	29,686.98	4,035.55	33,722.53

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.02	.11	0.00	.13
Dry Cargo	Large	0.00	.30	0.00	.30
Dry Cargo	Medium	0.00	.16	0.00	.16
Dry Cargo	Small	.01	.06	0.00	.07
Tanker	Large	0.00	.34	0.00	.34
Tanker	Medium	0.00	.02	0.00	.02
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.07	.98	0.00	1.05
Tanker Barge Tow	Large	0.00	.05	0.00	.05
Tanker Barge Tow	Small	.09	.79	0.00	.88
Tug/Tow Boat	Small	.01	.15	0.00	.16
Totals		.20	2.97	0.00	3.17
Candidate VTS Design - Dollars					
Passenger	Small	34,787.35	223,066.01	0.00	257,853.36
Dry Cargo	Large	0.00	604,449.94	0.00	604,449.94
Dry Cargo	Medium	0.00	324,378.88	0.00	324,378.88
Dry Cargo	Small	24,706.16	124,784.12	0.00	149,490.28
Tanker	Large	0.00	689,075.07	0.00	689,075.07
Tanker	Medium	0.00	32,457.31	0.00	32,457.31
Tanker	Small	326.67	0.00	0.00	326.67
Dry Cargo Barge Tow	Small	136,505.28	1,958,991.12	0.00	2,095,496.40
Tanker Barge Tow	Large	0.00	101,491.36	0.00	101,491.36
Tanker Barge Tow	Small	179,431.79	1,577,624.22	0.00	1,757,056.02
Tug/Tow Boat	Small	20,126.81	303,096.69	0.00	323,223.50
Totals		395,884.06	5,939,414.73	0.00	6,335,298.79

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix F   Zone 6 New Orleans, LA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010   7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	.00	.34	1.31	.16	1.81
ALCOHOLS	.01	.28	.84	.76	1.89
KEROSENE	.01	.02	.09	.00	.12
SULPHUR, LIQUID	.01	.40	1.29	.02	1.73
JET FUEL	.01	.07	.28	.00	.37
DISTILLATE FUEL OIL	.06	.31	1.20	7.03	8.60
GASOLINE, INCL NATURAL	.10	.47	1.74	.04	2.34
RESIDUAL FUEL OIL	.15	.73	6.67	9.51	17.07
CRUDE PETROLEUM	.46	1.81	2.79	.28	5.35
	.81	4.44	16.20	17.82	39.27

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix F Zone 6 New Orleans, LA
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	25,474	0	0
1996	0	1,382	32,617
1997	0	1,256	30,138
1998	0	1,142	27,417
1999	0	1,038	25,402
2000	0	944	23,341
2001	0	858	21,452
2002	0	780	19,725
2003	0	709	18,153
2004	0	645	16,701
2005	0	586	15,361
2006	0	533	14,150
2007	0	484	13,041
2008	0	440	12,015
2009	0	400	11,075
2010	0	364	10,182
	25,474	11,562	290,771

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	25,474	0	0
1996	0	1,756	41,441
1997	0	1,756	42,119
1998	0	1,756	42,148
1999	0	1,756	42,955
2000	0	1,756	43,417
2001	0	1,756	43,894
2002	0	1,756	44,397
2003	0	1,756	44,945
2004	0	1,756	45,485
2005	0	1,756	46,017
2006	0	1,756	46,630
2007	0	1,756	47,273
2008	0	1,756	47,910
2009	0	1,756	48,575
2010	0	1,756	49,124
	25,474	26,336	676,330

APPENDIX F

ZONE 6 - NEW ORLEANS, LA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New Orleans		(Port 6)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0601	102	1	Alewife	.0010	.0010	.0010	.0010
0601	102	42	Atlantic Thread Herring	.0017	.0017	.0017	.0017
0601	102	43	Bay Anchovy	.0017	.0017	.0017	.0017
0601	102	43	Striped Anchovy	.0026	.0026	.0026	.0026
0601	102	44	Striped Mullet	.9700	.9700	.9700	.9700
0601	102	128	Searobins (all)	.1237	.0395	.1105	.0342
0601	102	129	Blackcheek Tongue Fish	0.0000	0.0000	.0316	.0263
0601	102	129	Spotfin Tongue Fish	0.0000	0.0000	.0158	0.0000
0601	102	130	Planehead Filefish	.5263	0.0000	0.0000	0.0000
0601	103	8	Bluefish	.4800	.0070	.4800	.8600
0601	103	11	Weakfish	.0015	.0015	.0015	.0015
0601	103	50	Bonito	.0300	.0300	.0300	.0300
0601	103	51	Jack	.0070	.0070	.0070	.0070
0601	103	52	Amberjack	.0300	.0300	.0300	.0300
0601	103	54	Blue Runner	.0070	.0070	.0070	.0070
0601	103	55	Doulphin	.0030	.0060	.0030	.0030
0601	104	12	Tuna	.0080	.0080	.0080	.0080
0601	104	13	Swordfish	.0280	.0280	.0280	.0280
0601	104	14	Shark	.0100	.0100	.0100	.0100
0601	105	56	Lefteye Flounders (all)	.4487	.1750	.3750	.0750
0601	105	207	Summer Flounder	.0380	.2500	.2100	.2300
0601	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
0601	106	28	Tilefish	.0390	.0390	.0390	.0390
0601	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
0601	106	35	Atlantic Croaker	.3535	.3750	6.2500	4.0310
0601	106	36	Banded Drum	.0987	.0987	.0987	.0987
0601	106	36	Drum	.7895	.5526	.7500	.9276
0601	106	37	Spot	.0689	.0327	.0158	.0868
0601	106	40	Black Edge Cusk Eel	.0158	0.0000	.0026	.0021
0601	106	40	Eels	.0011	.0011	.0011	.0011
0601	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0601	106	47	Sand Sea Trout	.4798	.2886	1.4073	.3643
0601	106	48	Catfish	.1018	.0722	.0473	.3830
0601	106	60	Longspine Porgy	.5580	.0769	.0769	.6414
0601	106	60	Porgies	.2000	.2000	.2000	.2000
0601	106	61	Florida Pompano	.0070	.0070	.0011	.0070
0601	106	62	Grunt	.0120	.0120	.0120	.0120
0601	106	63	Pinfish	0.0000	0.0000	0.0000	.0455
0601	106	70	Snapper	0.0000	0.0000	.2012	0.0000
0601	106	71	Gulf Hake	0.0000	.0053	0.0000	.0158
0601	106	73	Silver Jenny	0.0000	.0210	0.0000	0.0000
0601	106	76	Sea Bass	.2404	.2763	.8882	.1768
0601	106	131	Rough Scad	0.0000	0.0000	.2012	0.0000
0601	106	132	Frogfish	.0395	.0395	.0395	.0395
0601	106	133	Pancake Batfish	.0526	0.0000	.3082	.0329
0601	106	134	Lizardfish	.0987	.0066	.0395	.0099
0601	106	135	Atlantic Medshipmen	.0360	0.0000	0.0000	.0158
0601	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
0601	108	209	Blue Crab	.0040	.0040	.0020	.0040
0601	108	215	Shrimp - Penaeus	.0592	.0085	.0204	.0204
0601	108	217	Crabs , Other	.0010	.0010	.0010	.0010
0601	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
0601	108	234	Rock Shrimp	.0005	0.0000	.0013	.0016

APPENDIX F

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New Orleans		(Port 6)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0601	109	207	Squid	.0083	.0830	.0830	.0083
0602	102	3	Gulf Menhaden	2.0300	2.0300	2.0300	2.0300
0602	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0602	105	56	Southern Flounder	.0380	.2500	.2100	.2300
0602	106	35	Atlantic Croaker	10.6300	9.0400	9.0400	5.6300
0602	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0602	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0602	106	45	Sheepshead	0.0000	.0950	.0950	0.0000
0602	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0602	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0602	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0602	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0602	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0602	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0602	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
0602	108	215	Shrimp - White, Pink, Brn	6.7000	14.3000	13.5000	6.3000
0603	102	3	Gulf Menhaden	2.0300	2.0300	2.0300	2.0300
0603	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0603	105	56	Southern Flounder	.0380	.2500	.2100	.2300
0603	106	35	Atlantic Croaker	10.6300	9.0400	9.0400	5.6300
0603	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0603	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0603	106	45	Sheepshead	0.0000	.0950	.0950	0.0000
0603	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0603	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0603	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0603	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0603	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0603	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0603	108	215	Shrimp - White, Pink, Brn	6.7000	14.3000	13.5000	6.3000
0604	102	3	Gulf Menhaden	2.0300	2.0300	2.0300	2.0300
0604	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0604	105	56	Southern Flounder	.0380	.2500	.2100	.2300
0604	106	35	Atlantic Croaker	10.6300	9.0400	9.0400	5.6300
0604	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0604	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0604	106	45	Sheepshead	0.0000	.0950	.0950	0.0000
0604	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0604	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0604	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0604	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0604	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0604	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0604	108	215	Shrimp - White, Pink, Brn	6.7000	14.3000	13.5000	6.3000

APPENDIX F

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish Larvae
Numbers per Square Meter

New Orleans (Port 6)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0601	202	1032	Mackerel	.5000	.5000	0.0000	0.0000
0601	202	1033	Mackerel	1.0000	1.0000	0.0000	0.0000
0601	202	1042	Herring	10.0000	1.0000	.1000	1.0000
0601	202	1043	Anchovy	1000.0000	10.0000	10.0000	100.0000
0601	202	1199	Larvae	2.1000	10.0000	1.0000	21.0000
0601	203	1053	Jack	1.0000	1.0000	.1000	0.0000
0601	203	1055	Dolphin	1.0000	1.0000	.1000	0.0000
0601	204	1136	Tuna	2.0000	0.0000	0.0000	0.0000
0601	204	1136	Tuna	2.0000	0.0000	0.0000	0.0000
0601	205	1199	Larvae	.5000	1.0000	.1000	1.0000
0601	206	1035	Croaker	10.0000	10.0000	0.0000	10.0000
0601	206	1068	Grouper	2.0000	2.0000	0.0000	0.0000
0601	206	1071	Snapper	1.0000	1.0000	0.0000	1.0000
0601	206	1120	Giobiidae	10.0000	10.0000	1.0000	10.0000
0601	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
0602	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0602	202	1043		53.0700	311.1000	2.1960	4.0260
0602	202	1121		.0366	.0092	.0183	0.0000
0602	202	1127	Silverside	.1281	.0366	.2196	.0366
0602	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0602	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0602	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0602	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0602	206	1036	Drums	.0275	.0458	0.0000	.0183
0602	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0602	206	1063	Pinfish	0.0000	0.0000	0.0000	1.006[illegible]
0602	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0602	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0602	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0602	206	1120	Gobies	.0092	.1830	.0092	.0183
0602	206	1120	Naked Goby	.2745	.0549	.0366	.0732
0602	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0602	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0602	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0602	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0602	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0602	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549
0602	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0602	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0603	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0603	202	1043		53.0700	311.1000	2.1960	4.0260
0603	202	1121	Gobies	.0366	.0092	.0183	0.0000
0603	202	1127	Silverside	.1281	.0366	.2196	.0366
0603	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0603	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0603	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0603	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0603	206	1036	Drums	.0275	.0458	0.0000	.0183
0603	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0603	206	1063	Pinfish	0.0000	0.0000	0.0000	1.0065
0603	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0603	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0603	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0603	206	1120	Gobies	.0092	.1830	.0092	.0183
0603	206	1120	Naked Goby	.2745	.0549	.0366	.0732

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New Orleans Port & Subzone	Species Category	(Port 6) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0603	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0603	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0603	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0603	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0603	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0603	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549
0603	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0603	208	1199	Larvae	.0160	.0420	0.0000	0.0000
0604	202	1003	Menhaden	.0366	0.0000	.0732	1.2627
0604	202	1043		53.0700	311.1000	2.1960	4.0260
0604	202	1121		.0366	.0092	.0183	0.0000
0604	202	1127	Silverside	.1281	.0366	.2196	.0366
0604	202	1244	Pipefish	.0549	.0183	0.0000	.0915
0604	203	1199	Larvae	12.2000	11.6000	.5500	0.0000
0604	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
0604	205	1242	Lined Sole	.2562	.3660	0.0000	0.0000
0604	206	1036	Drums	.0275	.0458	0.0000	.0183
0604	206	1046	Sea Trout	.2288	.2379	0.0000	0.0000
0604	206	1063	Pinfish	0.0000	0.0000	0.0000	1.0065
0604	206	1073	Mojarras	.0183	0.0000	0.0000	0.0000
0604	206	1073	Mojarras	.4941	2.0130	0.0000	.0092
0604	206	1120	Clown Goby	.2013	.4941	.0366	.0732
0604	206	1120	Gobies	.0092	.1830	.0092	.0183
0604	206	1120	Naked Goby	.2745	.0549	.0366	.0732
0604	206	1199	Other Larvae	0.0000	0.0000	0.0000	.0366
0604	206	1199	Other Larvae	0.0000	0.0000	.0183	0.0000
0604	206	1199	Other Larvae	0.0000	.0366	0.0000	0.0000
0604	206	1199	Other Larvae	.0183	.0092	.0092	.0366
0604	206	1199	Other Larvae	.0915	.4750	0.0000	0.0000
0604	206	1245	Skillet Fish	.0366	0.0000	0.0000	.0549
0604	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
0604	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX F

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New Orleans Port & Subzone	Species Category	(Port 6) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0601	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0601	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0601	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0601	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0601	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0601	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0601	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0601	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0601	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0601	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0601	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0601	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0601	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0601	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0601	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0601	111	515	Scaup	.6500	0.0000	.6500	.6500
0601	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0601	112	561	Blk. Crowned Knight Heron	1.0500	1.0500	1.0500	1.0500
0601	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0601	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0601	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0601	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0601	112	561	Louisiana Heron	12.0258	2.0500	2.0500	12.0258
0601	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0601	112	561	Snowy Egret	17.8204	16.0500	16.0500	17.8204
0601	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0601	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0601	112	572	Oyster Catcher	.0012	.0012	.0012	.0012
0601	113		Other Seabirds	2.3000	2.3000	2.3000	2.3000
0601	113	534	Tern	1.3014	1.3014	1.3014	1.3014
0601	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0601	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0601	113	548	Skimmer	1.9877	1.9877	1.9877	1.9877
0602	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0602	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0602	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0602	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0602	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0602	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0602	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0602	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0602	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0602	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0602	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0602	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0602	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0602	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0602	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0602	111	515	Scaup	.6500	0.0000	.6500	.6500
0602	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0602	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0602	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0602	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0602	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0602	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

New Orleans Port & Subzone	(Port 6) Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0602	112	561	Louisiana Heron	12.0250	2.0500	2.0500	12.0250
0602	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0602	112	561	Snowy Egret	17.8204	16.0500	16.0500	17.8204
0602	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0602	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0602	112	572	Oyster Catcher	.0012	.0012	.0012	.0012
0602	113	534	Tern	1.3014	1.3014	1.3014	1.3014
0602	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0602	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0602	113	548	Skimmer	1.9877	1.9877	1.9877	1.9877
0603	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0603	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0603	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0603	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0603	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0603	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0603	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0603	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0603	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0603	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0603	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0603	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0603	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0603	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0603	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0603	111	515	Scaup	.6500	0.0000	.6500	.6500
0603	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0603	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0603	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0603	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0603	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0603	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0603	112	561	Louisiana Heron	12.0250	2.0500	2.0500	12.0250
0603	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0603	112	561	Snowy Egret	17.8204	16.0500	16.0500	17.8204
0603	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0603	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0603	112	572	Oyster Catcher	.0012	.0012	.0012	.0012
0603	113	534	Tern	1.3014	1.3014	1.3014	1.3014
0603	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0603	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0603	113	548	Skimmer	1.9877	1.9877	1.9877	1.9877
0604	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0604	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0604	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0604	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0604	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0604	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0604	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0604	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0604	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0604	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0604	111	515	Common Goldeneye	.0100	0.0000	.0100	0100
0604	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500

APPENDIX F

ZONE 6 - NEW ORLEANS, LA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New Orleans		(Port 6)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0604	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0604	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0604	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0604	111	515	Scaup	.6500	0.0000	.6500	.6500
0604	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0604	112	561	Blk. Crowned Knight Heron	5.9078	5.9078	5.9078	5.9078
0604	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0604	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0604	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0604	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0604	112	561	Louisiana Heron	12.0250	2.0500	2.0500	12.0250
0604	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0604	112	561	Snowy Egret	17.8204	16.0500	16.0500	17.8204
0604	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0604	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0604	113	534	Tern	.0110	.0110	.0110	.0110
0604	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0604	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0604	113	548	Skimmer	.2133	.2133	.2133	.2133

APPENDIX G

HOUSTON/GALVESTON, TX

(ZONE 7)

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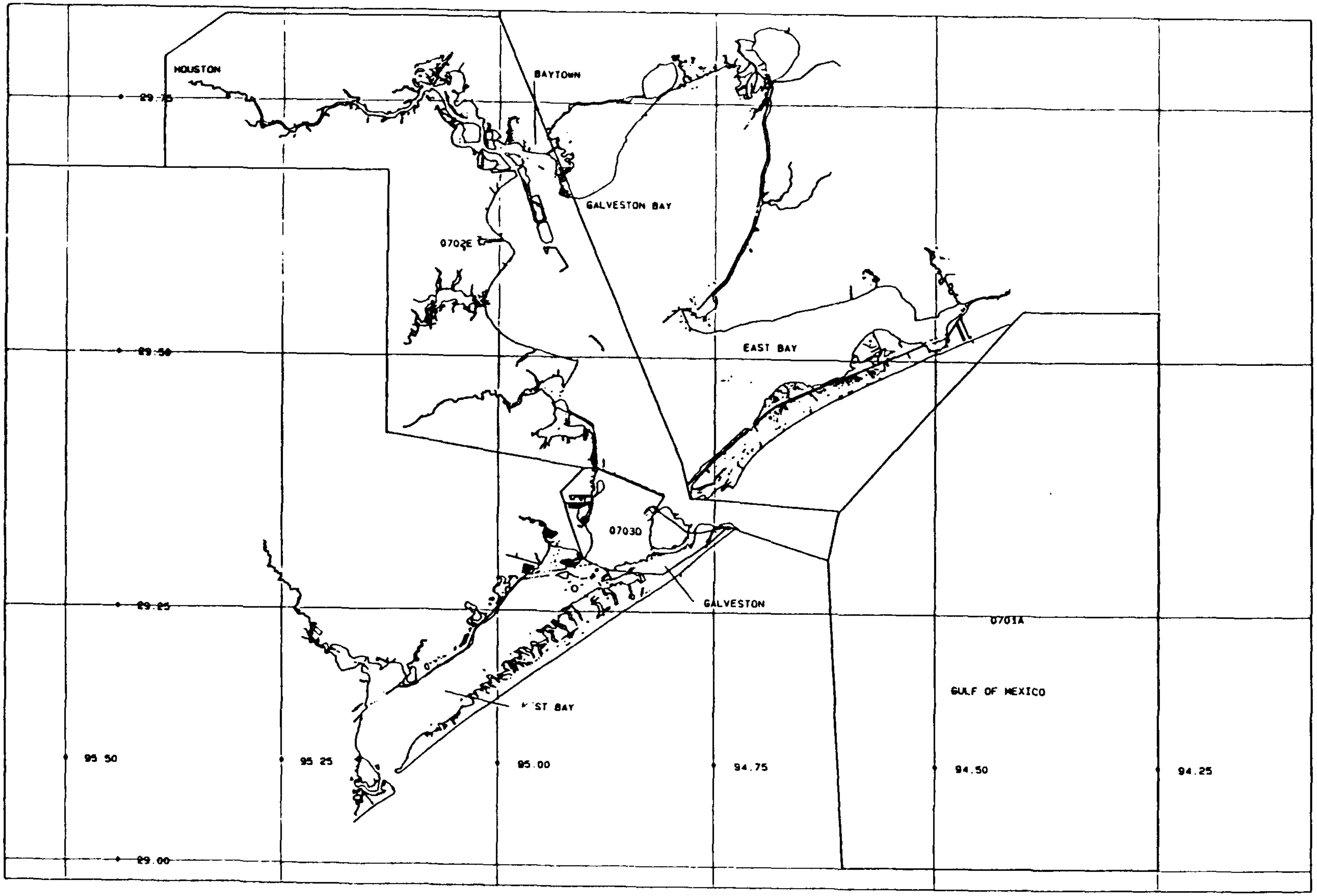
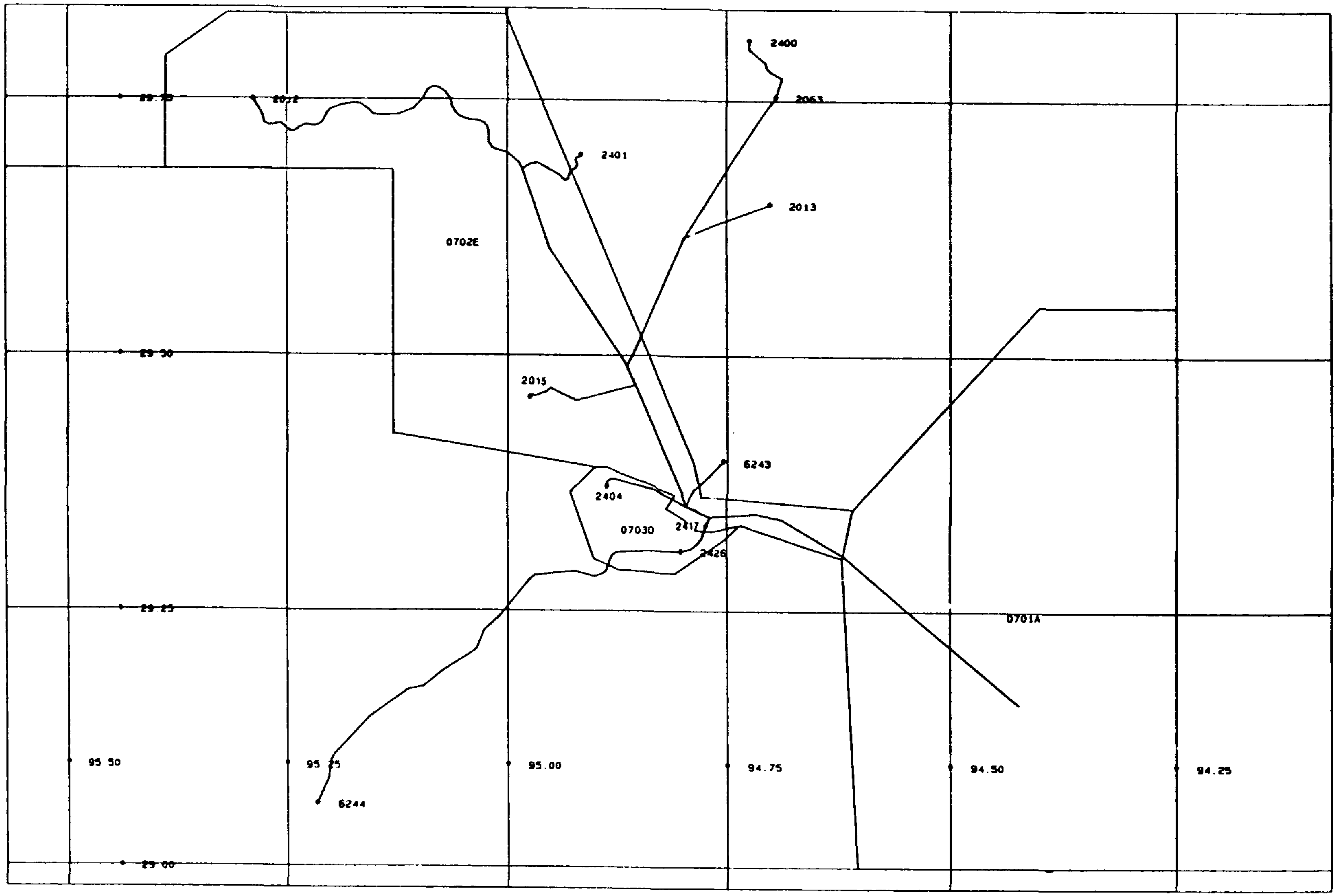
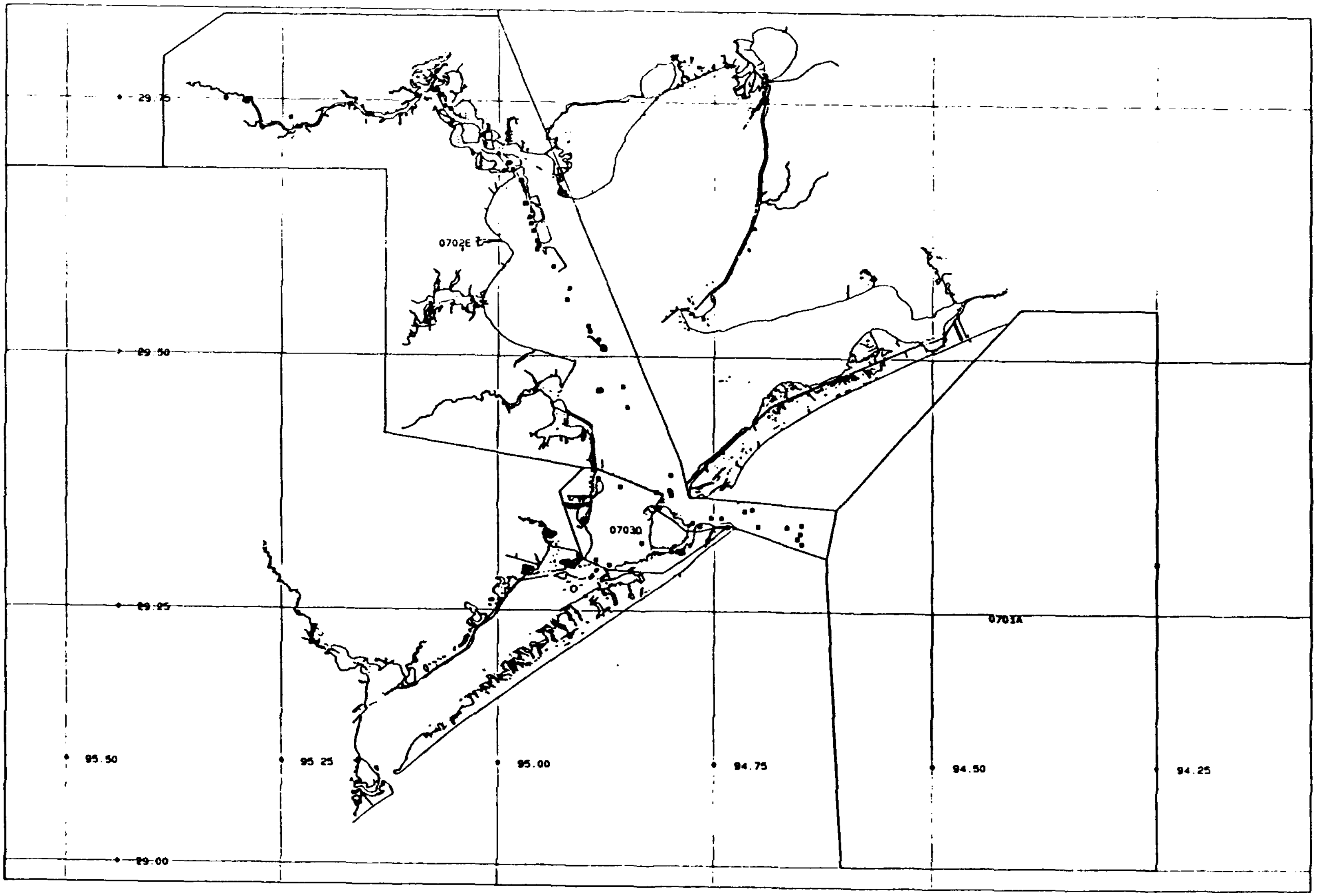
STUDY ZONE MAPS



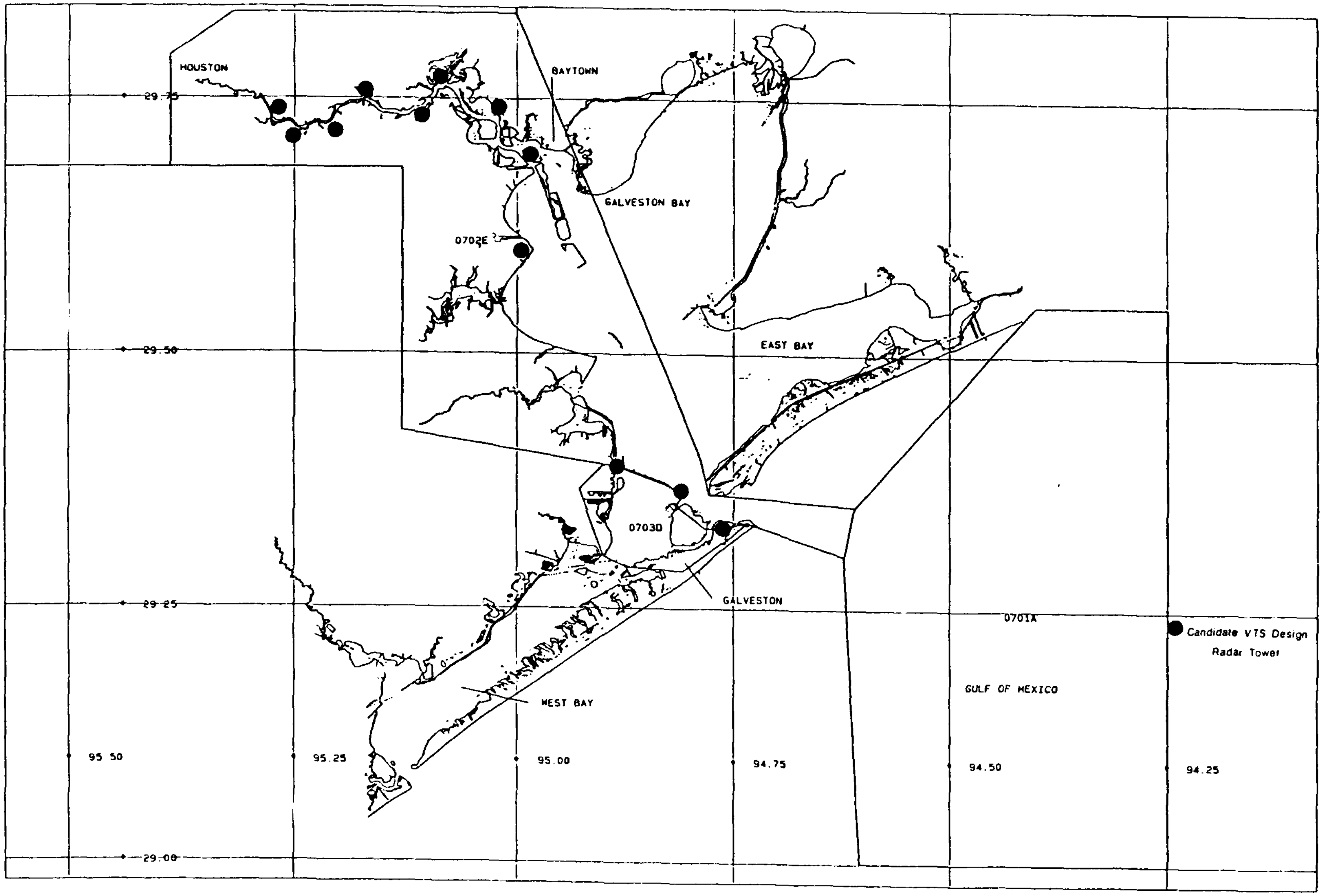
ZONE 7 - HOUSTON/GALVESTON, TX - ZONE AND SUBZONE BOUNDARIES



ZONE 7 - HOUSTON/GALVESTON, TX - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 7 - HOUSTON/GALVESTON, TX - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 7 - HOUSTON/GALVESTON, TX - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

HOUSTON/GALVESTON, TX

(ZONE 7)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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HOUSTON/GALVESTON VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Houston/Galveston, Texas. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 HOUSTON/GALVESTON PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the port and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems. Some inconsistencies in place names were noted among the various documents reviewed and where these occurred names appearing in the Coast Pilot were used (Reference 1).

The area of the survey includes, in general terms, the Port of Galveston, Galveston Bay and its facilities, the Houston Ship Channel, and the Ports of Texas City and Houston. The complex is one of the busiest ports in the United States, ranking third (after Valdez and Delaware Bay) in the tonnage of crude oil handled, and second (after New York) in the tonnage of petroleum products. The Head of Navigation for deep-draft traffic is at Houston Turning Basin (at the entrance to Buffalo Bayou), some 44 miles from the seaward entrance to Galveston Bay.

The port serves both deep-water and coastwise traffic, including Intracoastal Waterway (ICW) barges. Because of the volume of traffic it may be considered as the quintessential example of its type; having narrow, constricted channels with a mixture of deep-draft and inland traffic offering significant potential for incidents involving two or more vessels.

The port complex is located within an environmentally sensitive coastal region which, in addition to sensitive wetlands also supports significant commercial and sports fisheries.

2.2 OVERVIEW OF THE PORT

Climate within the study area varies considerably, given the separation of 40 plus miles between Galveston and Houston. The Galveston climate is characterized as typically marine sub-tropical, dominated by proximity of the Gulf of Mexico, Galveston Bay and the adjoining wetlands. During the winter months the prevailing winds shift from onshore to offshore, moderating the marine influence. Houston, by contrast, is more affected by the semi-arid climate of inland Texas, tempered somewhat during the summer months by onshore winds from the Gulf.

Poor visibility can be a problem, particularly during the winter months, and fog occurs primarily from November through April. Offshore visibility drops to 0.5 mile or less 1-2% of the time during that period, and Galveston records visibility of 0.25 mile or less about one day per month during December and January. The Galveston South Jetty Light 5A fog signal operates an average of 85 hours per month from December to March.

The diurnal tidal range at Galveston Bay Entrance is 2.0 feet and 1.0 foot at Houston, but the effect of wind can cause deviations of up to four feet from predicted levels. Currents through the Galveston Entrance average 1.7 knots on the flood and 2.3 knots ebb, but can also be modified significantly in velocity and direction by prolonged winds.

The majority of traffic serving the study area carries petroleum or various forms of hazardous cargo. There has been growth in container and ro-ro movement, but the long-term effects of POSTPANAMAX ships makes continuation of the trend uncertain. Commercial maritime facilities of all types abound within the study area and the U. S. Army Corps of Engineers' Port Series Reports No. 23 and 24 should be consulted for a complete tabulation. Galveston and the lower portion of Galveston Bay are host to a significant number of recreational, fishing and minor sized craft serving the offshore industry. The number of these diminish in the upper reaches of Galveston Bay and apparently do not contribute significantly to marine traffic in Houston.

The seaward approach to the area is through a series of Safety Fairways designed to insure unobstructed passage of deep-draft shipping through the profusion of offshore activity present throughout Gulf inshore waters. Approach navigation is facilitated by Loran-C coverage with good crossing angles. The Safety Fairways join some 20 miles offshore of the Galveston Entrance in one of the Precautionary Areas of the Galveston Traffic Separation Scheme (TSS). There are three Fairway Anchorages adjacent to the TSS.

Pilotage is compulsory for all foreign vessels and U. S.-flag ships under register, and optional for U. S. ships in the coastwise trade who have on board a Federally licenced pilot. The study area is served by two pilot organizations; the Galveston-Texas City Pilots and the Houston Pilots. The Houston Pilots serve all ports above Texas City. Pilots board and are discharged in the inshore Precautionary Area of the Galveston TSS, in the vicinity of Galveston Bay Entrance Channel Approach Lighted Buoy GB. The Galveston - Texas City Pilot boats guard VHF-FM Channels 14 and 16, and work on Channel 13. The Houston Pilots boats guard VHF-FM Channels 14 and 74, and their office also monitors Channel 74.

Galveston Entrance, the approach to Galveston Bay, lies between two stone-rubble jetties. A considerable number of unmarked dangerous wrecks exist in the approaches to Galveston Bay Entrance and a spoil bank lies south of the Outer Bar Channel. An extensive shoal area lies just south of the channel between the jetties. A Federal Project provides for an Entrance Channel of 42 feet from the Gulf to about two miles west of the outer end of the jetties, and 40 feet from that point to Galveston. The 40' depth is also carried some 42 miles up the Houston Ship Channel to the vicinity of Brady Island, and 36' from there to the Head of Deep-draft Navigation in Houston. The channel to Texas City is maintained at 37 feet. Project channels tend to be 400 feet in width although some points are considerably wider. The appropriate charts should be consulted for specific dimensions. Once above Bolivar Roads, man-made channels must be used by all except the most shoal draft craft and layberths or anchorages generally do not exist.

The limiting draft of the main channels, their narrowness and the 44 mile length of the Houston Ship Channel combine to define the major traffic management concerns for both deep-draft and inland shipping. For the deep-draft ships, channel depth imposes costly draft limitations, necessitating careful coordination of loaded ship transits with times of high water in order to carry maximum cargo. The narrow channel widths virtually rule out overtakings of or by larger ships, and makes their meetings occasions in which the potential for incidents is high. These potential difficulties can be seen by postulating the meeting of two ships of approximately the dimensions of the <u>ARCO FAIRBANKS</u> (120,266 Deadweight Tons (DWT), 883' Length Overall (LOA), 138' beam). The combined width of two such ships takes up nearly two-thirds of the available channel, requiring skillful exploitation of bank and hull-to-hull hydraulic effects for passing. These conditions have resulted in the so-called <u>"Texas Chicken"</u> maneuver, generally performed by conning the meeting ships in the center of the channel until the appropriate moment when each alters course toward the bank on its starboard hand, relying upon a combination of hydraulic cushion and bank suction for safe passing, and with each ship returning to channel center once clear. Draft considerations also require inland towboat/barge traffic to share the channels with deep-draft ships, and incompatible handling characteristics and handling

techniques complicate interactions between the types. The relatively orderly "column" pattern imposed by the channels is complicated by numerous channel junctions, and by crossing of the Houston Ship Channel by the ICW at nearly right angles.

2.3 EXISTING TRAFFIC MANAGEMENT

Existing vessel traffic management procedures are not well-publicized in comparison to other Gulf area ports with a similar configuration of long, narrow man-made channels (Corpus Christi, Lake Charles, New Orleans and Port Arthur). Those ports have established traffic management procedures set out in publications such as the Coast Pilot, readily available to all mariners. Such is not the case for the Galveston/Texas City/Houston area. Since these procedures are not well advertised, ships which are not required to take a pilot may be ignorant of the guidelines.

General regulations for all "waterways tributary to the Gulf of Mexico..." apply within the area and are published by 33CFR162.75. The regulations touch only upon some very basic matters and focus largely upon barge movement.

2.3.1 General Management Problems

Several problems complicate traffic management, but these are not unique to the Houston/Galveston area. Many mariners report abuse of Channel 13 through excessive transmitter power and using the channel for traffic not related to the safety of navigation. The congestion is exacerbated by the high volume of traffic between shipping and the VTS Vessel Control Center (VTC). Other than communications, most of the remaining problems seem to focus upon conflict between the different users; most notably failure of shoal draft craft to yield to deep-draft ships constrained by the channel and between ships and tugs/tows using the ICW. See Section 2.3.4 for related comments.

The towboat industry experiences problems of pilothouse workload exacerbated by communications requirements. The tugs normally operate with a single person on watch in the pilothouse. In addition to piloting this watchstander must also handle communications, perform a number of internal functions and frequently serves as the only lookout. As a result, the watchstander becomes saturated and this in turn frequently results in failure to guard or to communicate intentions on Channel 13.

While good information is generally available about movements and cargoes of shipping calling at facilities within the port complex, similar and reliable data is not readily available about ICW traffic just passing through the port. This absence of information complicates the process of passing that traffic smoothly and safely through the Houston Ship Channel flow, and uncertainties about ICW cargoes may inhibit adequate pollution prevention and response.

These general problems are of significance to system design. The most obvious impact is to impose surveillance requirements where they would otherwise not exist in order to cover known shortfalls of information. The difficulties of incorporating ICW data into the traffic management database also represents a major challenge.

2.3.2. Galveston Traffic Separation Scheme

An International Maritime Organization (IMO) approved Traffic Separation Scheme has been established in the approach to Galveston Bay from seaward (Reference 2).

2.3.3. Vessel Traffic Service (Houston/Galveston)

The Houston/Galveston Vessel Traffic Service (VTS) serves the study area, operating under the Authority of the Port and Waterways Safety Act of 1972 as a voluntary vessel movement reporting system. The VTS service area includes all the waterways from the approaches to Galveston Bay Entrance at the Gulf of Mexico through the entire Houston Ship Channel. Precautionary Areas (PA)[1] and Reporting Points are designated within the service area.

The stated function of the VTS is to collect and process information received from participating vessels, enhanced by CCTV and radar surveillance, and disseminate information to other participating vessels operating in the vessel traffic system area. This is achieved through the use of a Vessel Movement Reporting System (VMRS). The network of VHF-FM radio facilities along the waterway is the backbone of VTS operations. The goal is to improve vessel transit safety by providing vessels with advanced information of other reported marine traffic and any other information which may affect safe and orderly transit of vessels within the VTS area. With this system of "predictability on the waterways", the VTS seeks to reduce the dire consequences of marine accidents, prevent collisions and groundings and protect navigable waters from environmental hazards.

A Vessel Traffic Center (VTC) located in Houston monitors vessel movements with radar and closed circuit TV (CCTV) at various places along the waterway and communicates with "participating" vessel traffic on VHF-FM radio channels 11 or 12. Participants above Baytown utilize VHF-FM Channel 11 and those below Baytown use Channel 12. The VTC monitors Channel 13 continuously and that channel is used as a "hailing" frequency.

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[1] "Precautionary Area" as the term is used by VTS Houston/Galveston, differs from the IMO-approved terminology both in definition and in the strictures imposed upon mariners while operating within Precautionary Areas. The VTS use of the term is apparently only as an indicator of areas where significant traffic problems may occur.

Participation in the VTS is voluntary and recommended for vessels over 100 gross tons, certain vessels carrying passengers for hire, and towing vessels over 26 ft. Participants are asked to establish communications with the VTC 30 minutes before entering or beginning to navigate within the VTS area. Thereafter, they are asked to report when actually entering the VTS area; when passing one of the 15 designated reporting points or when deviating from movement intentions previously reported; when anchoring in the VTS area; in emergencies or when navigational capabilities are impaired; or when terminating passage, anchoring, mooring or departing the VTS area.

Reporting Points, identified by numbers or letters, are:

1. Galveston Bay Entrance Channel Lighted Buoys 11 & 12.
E. ICW mile 349 (Bolivar)
W. ICW mile 351 (Pelican Cut)
T. Texas City Channel Lighted Buoy 12
2. Houston Ship Channel Lights 31 and 32
3. Red Fish Bar Lights 1 and 2
P. Bayport Ship Channel Lights 5 and 6
4. Morgans Point abeam Baytown at Light 91
5. Baytown Bend abeam Exxon at Light 113
6. Lynchburg Ferry Crossing
7. Boggy Bayou abeam Shell at Light 142
8. Abeam Greens Bayou at Light 152
9. Hunting Bayou abeam Warren (Hess) at Light 160
10. Sims Bayou abeam Arco at Turning Basin
11. Interstate Route 610 Bridge at Manchester

2.3.4 Existing VTS Technology

Traffic surveillance is provided by the AN/FPS-121 Radar located on the east end of Galveston Island and by 8 CCTV sites located along the Houston Ship Channel between Morgans Point and Buffalo Bayou. The AN/FPS-121 Radar antenna is atop a 150' tower at the USCG facilities located at the extreme east end of Galveston Island. The radar transceivers (two each - one in "hot" standby) are located in a fiberglass shelter at the base of the tower.

This radar is specified as having a maximum range of 64 miles and effective range of 40 yards to 40 miles. The useful coverage reportedly extends south to Entrance Channel Buoy "GB" and north to just below Eagle Point. Radar video and remote control signals are encoded into digital telemetry, sent to the local telephone office via phone lines and then via one of two separate microwave paths to the VTC. Radar resolution is reported insufficient to adequately display contact information in the vicinity of land cuts at Pelican Cut and the Bolivar Peninsula and in Texas City Harbor.
Three 16-inch, radar PPI's are available in the VTC. Under normal operating procedures, PPI #1 is configured on the 12 mile scale to monitor traffic in lower Galveston Bay, including Red Fish Bar. PPI #2 is normally kept on the 6 mile scale to monitor traffic in Bolivar Roads. PPI #3 is configured on the 6 mile scale to monitor

traffic in the Bolivar Roads Anchorage and the Galveston Bay Entrance Channel.

The present surveillance coverage is not considered adequate between Red Fish Bar and the Bayport Ship Channel, a 7 mile gap. A Planning Proposal has been submitted to provide an additional radar at Eagle Point that would cover the 7 mile gap and provide needed surveillance of Texas City Harbor. Two additional 14-inch monitors would be added at the VTC. This is intended to permit better utilization of the Galveston radar to cover the Galveston entrance and approaches and preclude frequent range scale changes. Eagle Point property is available for lease, including privately owned and municipal utility property.

Eight CCTV sites are located along the Houston Ship Channel from Morgans Point to the Turning Basin at Buffalo Bayou. The CCTV coverage at each site defines a Precautionary Area. There are two cameras at each site mounted at various heights and with various lens capability. One camera monitors downbound traffic and the other upbound traffic. Camera video and control is provided through a Motorola microwave system. At the VTC only one camera at a time can be monitored from each site. Each camera is controllable in pan, tilt, zoom and focus and Infra-Red spotlight illumination is used at some sites to aid nighttime use. The cameras are mounted in weatherproof enclosures with built-in defoggers and wiper/washer assemblies for the enclosure face plate.

The Motorola Model S1177 Mocam cameras utilize silicon intensified target (SIT) vidicon tube assemblies with approximately 600 lines of resolution. Wide dynamic range of operation under various ambient light conditions is achieved with servo controlled neutral density filter lenses, AGC, and controlled high voltage. An air conditioned fiberglass building at the base of each CCTV tower contains microwave relay equipment, uninterrupted power sources, batteries and ancillary switching and control system. Suitable microwave antennas are mounted on the tower. A Larse Alarm and Control System is employed at each site to send site status information including intrusion alarms to the VTC. Details of the eight CCTV sites and their salient features are summarized in Table 2-1.

A Planning Proposal has been submitted to provide additional CCTV facilities on the radar tower at Galveston and at the Bayport Jetty with accompanying microwave relay systems. The purpose would be to provide visual surveillance of the Bolivar Roads Precautionary Area, Galveston Harbor, the Galveston Bay Entrance Channel and Bayport Harbor.

TABLE 2-1. CCTV SITE INFORMATION

Site Name	Tower Ht.	Ht. Cameras	Zoom	Infrared
Morgans Pt	170 ft	90/90 ft	10:1 20:1	yes
Mitchell's Pt. (Baytown)	170 ft	30/70 ft	10:1 10:1	yes
Lynchburg	170 ft	70/70 ft	10:1 20:1	yes
Jacintoport (Tucker"s Bayou)	170 ft	70/70 ft	10:1 20:1	yes
Greens Bayou	170 ft	100/100 ft	10:1 10:1	no
Hunting Bayou (Washburn Tunnel)	40 ft (on roof)	40/40 ft	10:1 10:1	no
Gatx (NOTE) (Sim's Bayou)	170 ft	100/100 ft	10:1 10:1	no
City Dock 27 (Buffalo Bayou)	180 ft	160/134 ft	10:1 10:1	no

NOTE: The GATEX Site is located in a volatile area at a chemical loading facility. This requires a blower fan and vent system in the fiberglass shelter to maintain a positive pressure inside the building and the installation of an automatic Halon fire control system.

The ship-to-shore voice communications system for the VTS consists of three separate communications sites; GALVESTON, MORGAN'S POINT and HOUSTON (VTC). Each site is equipped with two complete Motorola VHF-FM base stations - a six-channel transceiver and two guard receivers. The primary base station is on line and the other is in "hot" standby. Each transceiver is set up on CH11, CH12, CH13, CH14, CH16 and CH22A. GALVESTON and MORGAN's POINT guard receivers are set up on CH12 and CH13 while HOUSTON'S guard receivers monitor CH11 and CH13. All transmitting sites are normally kept on low power (1 watt) but can be switched to high power at the Supervisor's console. All transmitted and received audio is carried by phone lines.

Standard Operating Procedures for the VTS do not emphasize the need to minimize CH13 interference or assign to the VTC any role in providing channel discipline.

The GALVESTON site is located at the Coast Guard facilities on the east end of Galveston Island. Antennas are mounted on a 200' guyed tower and the redundant Motorola VHF-FM transceivers are housed in a fiberglass building at the tower base. The Galveston site provides communications for Sector I. Emergency backup power is provided by the emergency generators at the Coast Guard facilities. The MORGAN's POINT site provides communications for Sector II. Antennas are mounted on the 170' tower and the communications equipment is housed in one of two fiberglass buildings at the base of the tower. Emergency power is provided by a battery pack with eight hours' endurance.

The Houston (VTC) site provides communications for Sector III. Antennas are located on the 110' self supporting tower atop the VTC and the VHF-FM base stations are located in the VTC equipment room. Emergency power is provided by the emergency generator at PSSTA Houston.

The VTC and its associated equipment are located on the second floor of the Port Safety Station, Houston. Microwave and communications antennas are located on the roof-top 110' self-supporting tower. The Operations Center includes the operating consoles, CCTV monitors, radar PPI's and ancillary equipment. A separate Equipment Room houses video and radar microwave equipment, the VHF-FM Base Stations, the vessel tracking (DACS) CPU, and other support equipment.

Each console in the Operations Center contains control equipment for the VHF-FM radios and CCTV cameras. Communications sites can be individually selected or combined. The Sector I console normally handles communications on CH12 from the GALVESTON site with traffic located in the Houston Ship Channel from Bell Buoy No.1 to between Red Fish Bar Lights Number 1. and 2, the portions of the ICW within the VTS, and the Galveston and Texas City Channels. Sector II console normally handles communications on CH12 from the MORGAN's POINT site with traffic located from the northernmost end of Sector I in Galveston Bay to the Common Front Range Light of Ranges "O" and "T" north of Baytown and the Bayport Channel. Sector III console normally handles communications on CH11 from the HOUSTON (VTS) site with traffic located in the Houston Ship Channel from the end of Sector II to the Turning Basin at the entrance to Buffalo Bayou. When traffic is light, Sectors I and Sector II communications are combined and handled at one VTC console. Video monitors and CCTV remote control equipment are distributed among the Sector consoles and an Ex-Com console. Each console, including the Watch Officers Position, has a VT-DACS terminal. The radar displays (3) are not integrated into the Sector consoles.

A Vessel Traffic Data Acquisition and Control System (VT-DACS) is utilized to display and process vessel traffic information. The systems consists of a central computer (two separate CPU's), command keyboards, CRT displays and printers. One CPU is always on - the other is in standby. The VT-DACS provides visual plots of each sector's traffic on a CRT display. Vessel position and Speed of Advance (SOA) information is entered at the Sector keyboard. The VT-DACS computer then advances the position of the vessel and displays its position along the track. Symbols are utilized to indicate types of traffic and other information along the waterway such as aids to navigation discrepancies, special operations, and COTP directives. Because this system has a history of unexpected failures, a manual tracking system called the "Manual Board" serves as a back-up to the DACS computer. Even when the DACS computer is operating, a condensed version of the Manual Board called the "mini-board" is maintained. Plans are to replace the DACS computer with a more reliable computer tracking system but it is understood that this replacement system also will utilize manual data input of position and SOA.

The Manual Board is made from two separate sheets of plywood. One covers the area from the Galveston Bay Entrance Channel to Five Mile Cut on the Houston Ship Channel and includes Galveston Harbor, Texas City, and the ICW. The second section covers the Houston Ship Channel from Five Mile Cut to Buffalo Bayou. A series of "slots" in the board hold data cards permitting the operator to plot, display and generally keep track of vessels in the VTS area. Each slot represents 1/4 mile in Sectors II and III and 1/2 mile in Sector I. The Vessel Status Cards, representing traffic traversing the ship channel, are moved manually along the board based upon a set of predetermined rules.

Unexpected "slow-downs" of traffic any place in the system seem to cause considerable management problems for the VTC. There are special slow-down procedures and reporting requirements invoked whenever this occurs. This is probably due, at least in part, to the fact that the VTS is SOA and dead-reckoning dependent - either by computer or with the manual boards.

The Houston/Galveston VTS is highly people-intensive to operate and manage. CCTV surveillance from eight camera sites, the frequent use of the "Manual Board", and the use of radar surveillance with limited acquisition and tracking capability are the primary causes of this situation. Also, with better automatic tracking and detection capabilities, voice communications could be considerably reduced.

The VTC relies in great part on the receipt of reliable and accurate movement reports from participating vessels particularly in the areas not under surveillance by CCTV. The Sector Operators must use significant personal judgement and spend considerable time on voice radio to manage their Sectors.

Although existing traffic management is a problem in Texas City and future plans call for increases in traffic to and from that area, there are no known plans to improve surveillance (visual or radar) in that area (e.g., Snake Island Bend) except with what might be achieved with the new proposed radar at Eagle Point.

2.3.5 VTS-related Traffic Management Problems

Numerous offshore vessels reportedly transit in and out of Galveston without participating in the VTS even though they meet the criteria for such voluntary participation.

Radar surveillance presently is not effective in sorting out participating and non participating vessel traffic in the Galveston - Bolivar Roads area. Vessel identification is difficult and the VTC relies upon radio communications to manage the traffic and verify radar targets.

After periods of reduced visibility, numerous vessels get underway and enter the VTS service area simultaneously. The result is sudden increase and overload of the communications channels in sorting out the traffic.

Numerous tows, many over 100 ft wide and/or 800 ft long, lie to by "pushing-in" inside Bolivar and Pelican Cuts and cannot be detected by the VTS radar on Galveston Island.

The continued dependence of the Houston/Galveston VTC on frequent and extensive radio reports to manage traffic is leading to extensive overuse and interference on the VTS and other communications channels. Although the filing of movement reports with the VTC provides a running source of traffic information to everyone listening on the VTS channel, during periods of heavy traffic the communications channels are almost constantly busy. This is a result of Participating vessels which report at the 15 Reporting Points or with the VTC engaged in receiving vessel data or trying to sort out surveillance targets and non participants. VTS technology should be applied to permit more efficient handling of vessel traffic and allow minimum use of voice radio communications. The Houston/Galveston VTS was originally designed around the use of voice radio, CCTV surveillance and computer tracking of vessels based upon their reported positions and the vessels Speed of Advance (SOA) along the waterway. CCTV is utilized to verify that participants are where they report to be and to observe non-participating traffic. Apparently Commandant Instruction M16000.11 specifies **visual** surveillance as the preferred means of obtaining and evaluating VTS information. Radar has been added to provide all weather surveillance outside the CCTV areas of coverage. The computer tracking system has been subject to frequent failures and the VTC has become dependent upon manual plotting systems to keep track of participants. While this has resulted in stable VTS operations, the effect is a highly people-intensive process dependent upon considerable personal judgement

and a high level of training for VTC personnel. Modern VTS technology would permit more efficient utilization of people through better automatic surveillance and tracking systems and data processing.

2.4 VESSEL TRAFFIC

The 1987 Statistics (Reference 3), Tables 2-2 and 2-3, confirm the study area as one of the busiest port complexes in the United States.

TABLE 2-2. 1987 CARGO STATISTICS

	TOTAL FREIGHT	CRUDE OIL	PETROLEUM PRODUCT
GALVESTON	8.7	0.2	0.6
TEXAS CITY	37.2	22.6	6.0
HOUSTON	112.5	24.4	29.3
STUDY AREA TOTAL	158.4	47.2	35.9

Note: Data in millions of tons. "Product" includes gasoline, jet fuel and fuel oil only.

The study area ranked second only to New Orleans in terms of total cargo handled, third after Valdez and Delaware Bay in tonnage of crude oil and second to New York in petroleum products handled.

In terms of numbers of tanker movements the study area is second only to the Delaware Bay/Delaware River, and that by just a small margin. It leads the nation in barge movements, being ahead of the next busiest port by some 8,000 movements per year. In assessing the barge data one must keep in mind that the figures include only barges loading or landing cargo within the study area. They **DO NOT** include ICW traffic which simply passes through the study area. One must also recognize that tabulations of barge movements alone convey a distorted picture of the overall volume of traffic. Barges are normally combined to form "tows", and it is the tows that represent the majority of the inland traffic - not individual barges.

TABLE 2-3. 1987 VESSEL MOVEMENTS

	TANKER		BARGE	
	IN	OUT	IN	OUT
GALVESTON	70	74	293	275
TEXAS CITY	650	652	4160	4097
HOUSTON	1833	1851	19988	20089
STUDY AREA TOTAL	2553	2577	24341	24461

2.5 ENVIRONMENTAL SENSITIVITY

The offshore area, shoreline and bay areas within the study area support commercial and recreational fisheries, aquatic bird populations and general recreation. Galveston Bay itself is considered essential to maintenance of the Gulf shrimp population. The inshore wetlands have not, according to some sources, survived the effects of past pollution. Some of the islands and shoals within the Bay have been characterized as supporting no life (Reference 4).

"Worse Case," in terms of a pollution incident, is probably a major spill of crude oil in the Approaches during the winter months, coupled with a strong northerly wind. The slick could threaten the environmentally sensitive beaches of the littoral islands to the southwest of Galveston. Economically, however, "Worse Case" undoubtedly is an incident disrupting the flow of traffic in the Houston Ship Channel and/or the ICW for an extended period. Any spill inside Galveston Entrance probably can be contained with relative ease but the economic consequences of extended shipping delays could be catastrophic. The most threatening incident is considered to be one causing the release of toxic vapors near population centers, and the most likely is a 50-100 thousand gallon spill of petroleum product in the Houston Ship Channel resulting from an incident involving a barge, or barges.

2.6 Port Sub-Zones

The port was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 6). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

2.6.1 Sub-Zone I - Galveston Bay Approaches (NOAA Chart 11323)

Sub-Zone I consists of the Gulf Approaches to Galveston Bay seaward of a line between 29^0-17.5'N 94^0-47.1'W, 29^0-01.2'N 94^0-35.3'W, 28^0-57.3'N 94^0-26.2'W, 28^0-57.3'N 94^0-23.9'W, 29^0-02.1N 94^0-13.5'W, 29^0-03.8'N 94^0-12.1'W, 29^0-15.3'N $94^0$12.9'W, and 29^0-31.2'N 94^0-29'W.

The Approaches sub-zone lies a significant distance offshore, in order to provide for establishing communications with inbound ships at least 30 minutes prior to arrival at the offshore Precautionary Area of the Galveston TSS. This provides the opportunity for the VTS to assist in safe passage through the offshore Precautionary Area, to initiate queuing for port entry and pilot pickup, when required, and to adjust estimated times of arrival (ETA) to minimize waiting periods spent either at anchor or standing off.

The sub-zone is classified as "confined-simple." Confinement accrues from the necessity to remain within the Safety Fairways.

2.6.2 Sub-Zone II - Galveston Entrance (NOAA Chart 11323)

Sub-Zone II consists of that portion of the waterway inshore of Sub-Zone I and seaward of the COLREGS Demarcation Line across Galveston Entrance.

The sub-zone includes the entire Galveston TSS, the pilot boarding area and the Fairway Anchorages. Management of traffic within this sub-zone is critical safety within the inshore Precautionary Area of the Galveston TSS, to regulation of the inbound flow from seaward into the port and to minimizing interferences within Sub-Zone III.

The sub-zone is classified as "confined-complex." The complexity is introduced by the nature of possible interactions in the Precautionary Areas, maneuvering to pick up or drop pilots and the presence of the anchorages.

2.6.3 Sub-Zone III - Bolivar Roads (NOAA Chart 11324)

The boundaries of the Sub-Zone III are formed by the COLREGS Demarcation Line across Galveston Entrance, lines across the ICW at Mile 345 and Mile 355, a line across the Houston Ship Channel drawn between Houston Ship Channel Lighted Buoys 35 and 36, a line drawn across the Texas City Channel and normal to its axis at Texas City Channel Buoy 12, and drawn across Galveston Channel and normal to its axis from the fixed red lights marking the southwest corner of the ferry slips.

This sub-zone can be regarded as the "Times Square" of Galveston-Houston shipping, and may well be is one of the more challenging marine traffic areas in the United States. It is a convergence zone for several major channels, is subject to a heavy volume of commercial traffic of various vessel types and supports considerable traffic falling below the IMO recommended VTS threshold length of 20 meters. A car ferry route also runs through the sub-zone.

The sub-zone limits have been generally drawn to provide sufficient time for VTS interaction between a vessel's entry into the sub-zone and its arrival at one of the more likely locations where interaction with another craft is likely to occur. Areas with lower probabilities of interaction or with different types of management concerns, such as the upper Texas City Channel, have been deliberately excluded from this sub-zone to help focus management attention upon areas of highest risk.

The sub-zone is classified as "confined-complex."

2.6.4 Sub-Zone IV - Galveston Harbor (NOAA Chart 11324)

Sub-Zone IV is bounded to the north by a line across Galveston Channel from the fixed red lights at the southwest corner of the ferry slips, and to the south by a line across the Alternate ICW at Buoy 10.

Traffic within this sub-zone is but a fraction of the overall volume of the port complex. It is therefore felt that the major management concern is coordination of movement of traffic from this sub-zone into Sub-Zone III so as to merge smoothly and safely with the main channel flow.

The sub-zone is classified as "confined-complex."

2.6.5 Sub-Zone V - Texas City (NOAA Chart 11324)

Sub-Zone V includes Texas City from a line drawn across the Texas City Channel and normal to its axis at Texas City Buoy 12 to the Head of Navigation at Texas City.

Traffic within this sub-zone, while only about 10% of the study area's total, approaches that of Corpus Christi when measured by the yardstick of petroleum carrier movement. While the first concern must of necessity be to coordinate movement of traffic from this sub-zone into Sub-Zone IV, attention must also be paid to minimizing the potential for interactions within the sub-zone itself, particularly at or near the turn just east of the Texas City Turning Basin and in the Snake Island Safety Zone. (Reference 6).

The sub-zone is classified as "confined-complex."

2.6.6 Sub-Zone VI - Galveston Bay (NOAA Chart 11327)

Sub-Zone VI consists of that portion of Galveston Bay west of the eastern limits of the Houston Ship Channel and bounded to the south by the limits of Sub-zone III (a line across the Houston Ship Channel drawn between Houston Ship Channel Lighted Buoys 35 and 36) and to the north by a line drawn across the Houston Ship Channel and normal to its axis between Houston Ship Channel Lights 79 and 80, extended to intercept the shoreline. The sub-zone also includes Trinity River Channel for a distance of two miles east of its intersection with the Houston Ship Channel and all of Five Mile Cut.

The sub-zone encompasses some 17 miles of the Houston Ship Channel, the series of shoal- and deep-draft ports along the western shore of Galveston Bay, and the junction of the main channel with two shallow draft entrances to it from the east. The Project width of the Houston Ship Channel is 400 feet throughout the sub-zone, and major concerns are the maintenance of safe spacing between vessels, arranging safe meetings within the limits of the channel, and management of traffic leaving and joining the main channel at the various intersections within the sub-zone.

The sub-zone is classified as "confined-complex".

2.6.7 Sub-Zone VII - Hog Island-San Jacento Reach (NOAA Charts 11328 and 11329)

The Sub-Zone VII consists of that portion of the Houston Ship Channel between the northern boundary of Sub-zone VI (a line drawn across the Houston Ship Channel and normal to its axis between Houston Ship Channel Lights 79 and 80, extended to intercept the shoreline) and a line drawn across the Houston Ship Channel between the towers on either side of the Channel just west of Carpenters Bayou. The sub-zone includes Barbours Cut, Cedar Bayou Channel to Cedar Bayou Daybeacon 18, Upper San Jacento Bay, Baytown and Carpenters Bayou.

Major concerns within this sub-zone are the maintenance of safe spacing between vessels, arranging safe meetings within the limits of the channel, and management of traffic leaving and joining the

main channel at the various intersections. In addition, large ships should be prevented from meeting when negotiating the several significant bends in the main channel.

The sub-zone is classified as "confined-complex."

2.6.8 Sub-Zone VIII - Houston (NOAA Chart 11329)

The sub-zone consists of all of the Houston Ship Channel between the western limit of Sub-zone VII (a line drawn across the Houston Ship Channel between the towers on either side of the Channel just west of Carpenters Bayou) and the Head of Deep Draft Navigation at Houston Turning Basin.

The primary management task within the sub-zone is the coordination of movement in the channel with that of vessels maneuvering to make and leave berths, and to turn. Particular care should be taken to minimize the potential for incidents at the LPG terminal at Huntington Bayou.

The sub-zone is classified as "confined-complex."

2.7 Problem Area Identifiers (TABLE 2-4)

2.7.1 PAI II-1. Outer Precautionary Area

The Outer Precautionary Area represents the junction of four Safety Fairways with two lanes of the Galveston TSS. Annual tanker movements through the Precautionary Area exceed 5000 per year, warranting a basic level of management to minimize the risk of collision.

2.7.2 PAI II-2. Inner Precautionary Area

The Inner Precautionary Area contains the pilot boarding area and is the location at which many ships departing the Fairway Anchorages join the inbound traffic flow. In addition small vessels (fishing craft, offshore support vessels, recreational boats, etc.) using Galveston Entrance Channel intermix with larger shipping.

2.7.3 PAI II-3. Fairway Anchorages

The Fairway Anchorages represent a management tool of considerable value when poor visibility, an obstruction, or other condition requires queuing of inbound shipping to facilitate safe movement. The capability to manage the anchorages, and to have real-time information about ship locations and movements within them, contributes to overall safety of movement.

TABLE 2-4. HOUSTON/GALVESTON PROBLEM AREA IDENTIFIERS

PAI #	LOCATION	PROBLEM	MANAGEMENT
II-1	Outer Precautionary Area	Potential congestion at the junction of the safety fairways and TSS lanes	Have real-time knowledge of both participant and non-participant locations and movement. Be able to correlate all movements, provide movement management advise and alerting.
II-2	Inner Precautionary Area	Potential congestion and dissimilar traffic. Large percentage of non-participants.	Have real-time knowledge of both participant and non-participant locations and movement. Be able to correlate all movements, provide movement management advise and alerting.
II-3	Fairway Anchorages	Anchorage management critical to queuing and safety.	Have real-time knowledge of ship location and movement coupled with ability to coordinate movements with queuing requirements. Real-time tidal and meteorological information.

TABLE 2-4. HOUSTON/GALVESTON PROBLEM AREA IDENTIFIERS (Cont.)

PAI #	LOCATION	PROBLEM	MANAGEMENT
III-1	Federal Anchorage	Anchorage management critical to queuing and safety	Have real-time knowledge of ship location and movement coupled with ability to coordinate movements with queuing requirements. Real-time tidal and meteorological information.
III-2	Bolivar Roads Channel	Congestion, random movements, dissimilar traffic with large percentage of non-participants	Have real-time knowledge of both participant and non-participant locations and movements. Be able to correlate all movements, provide movement management advise and alerting.
III-3	ICW Intersection	Intersecting channels and merging of traffic types plus the level of activity introduces significant risk of incidents.	Have real-time knowledge of both participant and non-participant locations and movements. Be able to correlate all movements, provide movement management advise and alerting.

TABLE 2-4. HOUSTON/GALVESTON PROBLEM AREA IDENTIFIERS (Cont.)

PAI #	LOCATION	PROBLEM	MANAGEMENT
V-1	Snake Island Bend	Channel bend may prevent timely visual detection of traffic.	Have real-time knowledge of both participant and non-participant locations and movements. Be able to correlate all movements, provide movement management advise and alerting.
VI-1	Red Fish Bar	Intersecting channels and merging of traffic types introduces significant risk of incidents.	Management traffic flows to prevent interaction between vessels.
VI-2	Bayport Channel Junction	Intersecting channels and merging of traffic types introduces significant risk of incidents.	Manage traffic flow to prevent interaction between vessels.
VII-1	Morgan's Point	Narrow channels, bends, and overall traffic volume introduces significant risk of incidents	Manage traffic flow to prevent interaction between vessels.

TABLE 2-4. HOUSTON/GALVESTON PROBLEM AREA IDENTIFIERS (Cont.)

PAI#	LOCATION	PROBLEM	MANAGEMENT
VII-2	Blackwell Peninsula Bend	Narrow channel, bends, and overall volume of traffic introduces significant risk of incidents	Manage traffic flow to prevent interaction between vessels.
VII-3	Lynchburg Ferry Crossing	Cross channel ferry movements increase the risk of incidents	Manage traffic flow to prevent interaction between vessels.
VII-4	Baytown	Narrow channel, bend and traffic volume pose significant risk of incidents. Outbound deep-draft ships must take wind-driven depth changes into consideration.	Manage traffic flow to prevent interaction between vessels. Provide tidal data as required.
VII-5	Carpenter's Bayou	Narrow channel, activity and traffic volume pose significant risk of incidents. Outbound deep-draft ships must consider depth changes.	Manage traffic flow to prevent interaction between vessels. Provide tidal data as required.

2.7.4 PAI III-1. Federal Anchorage

The Federal Anchorage (Reference 7) just to the north of the main channel immediately inside Galveston Entrance is a management resource of great value during bad weather or in the queuing process when that becomes necessary. The capability to manage the anchorage, and to have real-time information about ship locations and movements within it, contributes to overall safety of movement.

Prolonged high wind conditions can cause deviations from predicted tidal levels exceeding two feet. The anchorage represents the last opportunity to adjust traffic flow in response to low water conditions in the Upper Bay.

2.7.5 PAI III-2. Bolivar Roads Channel

The Bolivar Roads Channel has the potential for a high level of congestion and near-random traffic movement. For example, it is here that ferry traffic between Galveston and the Bolivar Peninsula enters and leaves the major channels. The Galveston and Texas City Channels branch from the main channel, and shipping bound for each of those ports from sea turn across main channel outbound traffic, and there can be moderate to heavy small craft traffic (fishing, offshore support and recreational vessels).

2.7.6 PAI III-3. ICW Intersection

The ICW crosses the Houston Ship Channel and the Alternate ICW crosses and runs with the main channel for a short distance.

2.7.7 PAI V-1. Snake Island Bend

Traffic entering and departing from the Texas City Turning Basin are required to make a large course change immediately north of Snake Island. Knowledge of ship positions and movement is required in order to properly advise and manage traffic.

2.7.8 PAI VI-1. Red Fish Bar

The Trinity River Channel intersects the Houston Ship Channel in the vicinity of Red Fish Bar. Although the Trinity Channel is unmarked by aids to navigation and no longer maintained the area is a focal point at the beginning of the spoil banks where shoal-draft shipping can exit and enter the channel from the eastern portion of Galveston Bay.

2.7.9 PAI VI-2. Bayport Channel Junction

The Bayport Channel area, including Five Mile Cut, is a location at which shoal-draft traffic can cross, depart or join the traffic flow in the Houston Ship Channel. Deep-draft shipping entering Bayport Channel must turn across the outbound flow of main channel

traffic. When proceeding from the Bayport Channel to sea, deep-draft ships must merge with that flow. Knowledge of ship positions and movement is required in order to properly advise and manage traffic.

2.7.10 PAI VII-1. Morgans Point

The Morgans Point area is a place at which shoal-draft traffic can cross, depart or join the traffic flow in the Houston Ship Channel. Deep-draft shipping entering Barbours Cut must turn across the outbound flow of main channel traffic. When proceeding from the Cut to sea, deep-draft ships must merge with that flow. In addition, large ships should not meet at the narrows off Morgans Point itself. Knowledge of ship positions and movement is required in order to properly advise and manage traffic.

2.7.11 PAI VII-2. Blackwell Peninsula Bend

The channel bend southwest of Blackwell Peninsula is an area where meetings may make negotiation of the turns difficult. Safety is enhanced by preventing meetings of large ships at this location, based upon the ability to manage vessel speeds of advance (SOA) with real-time along track positional information.

2.7.12 PAI VII-3. Lynchburg Ferry Crossing

The Lynchburg ferry crosses the main channel traffic flow at approximately right angles. The ability to manage its movements relative to other traffic represents a significant safety feature.

2.7.13 PAI VII-4. Baytown

The Baytown area is a location where shoal- and deep-draft traffic depart and join the traffic flow in the Houston Ship Channel, and do so while main channel traffic is making a 20-30 degree course change to conform to the channel. Knowledge of ship positions and movement is required in order to properly advise and manage traffic.

2.7.14 PAI VII-5. Carpenters Bayou

Carpenters Bayou is a location where shoal- and deep-draft traffic depart and join the traffic flow in the Houston Ship Channel, and do so at a point where the main channel traffic begins or is steadying from a 20-30 degree course change to conform to the channel. Knowledge of ship positions and movement is required in order to properly advise and manage traffic.

3.0 HOUSTON/GALVESTON VTS DESIGN

3.1 INTRODUCTION

A detailed survey of Houston/Galveston Harbors is the basis for this design. An approach to costing VTS systems is outlined in Vol.III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 1). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The eight sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- Percentage of vessels of the desired minimum size detected in designated surveillance areas
- Percentage of lost tracks
- Accuracy of the position and track obtained
- Reliability of the surveillance system
- Timeliness of the data obtained
- Ability to interpret and use the data obtained

Secondary criteria are:

o Cost of the VTS system -- reduction of manpower by the use of technology

o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Houston/Galveston VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 Design Decisions (FIGURE 3-7)

3.2.1 Hardware Location and Selection

3.2.1.1 Sub-Zone III

East End of Galveston Island	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF
East End of the Texas City Dike	1 Module 3 radar 1 Module 13 MET 1 Module 15 HYD

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Existing Radar/Comm Facilities are Sufficient
II																			Radar Coverage from Sub-Zone III
III	1		1							1	1		1		1				
IV																			
V	1									1			1						
VI	1									1									Some Required Coverage is Provided by Radar From Sub-Zone VII
VII	3									2			1						
VIII	5									2	1		1						

FIGURE 3-1. PORT OF HOUSTON/GALVESTON, TX SURVEILLANCE SURVEY

3.2.1.2 Sub-Zone V

West End of the Texas City Dike	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET

3.2.1.3 Sub-Zone VI

Red Bluff	1 Module 1 radar 1 Module 10 VHF

3.2.1.4 Sub-Zone VII

West End of Hog Island	1 Module 1 radar 1 Module 10 VHF
Baytown	1 Module 10 radar
Lynchburg Landing	1 Module 1 radar 1 Module 10 VHF

3.2.1.5 Sub-Zone VIII

Patrick Bayou	1 Module 1 radar
Greens Bayou	1 Module 1 radar 1 Module 11 VHF 1 Module 10 VHF 1 Module 13 MET
Champion Paper Company	1 Module 1 radar
Manchester Terminal Corporation	1 Module 1 radar 1 Module 10 VHF
City Dock 27	1 Module 1 radar

3.2.2 Vessel Traffic Center

Since this Port naturally divides into an entrance/bay area and a long, narrow canal area with distinctly different traffic management problems, two separate Vessel Traffic Centers are employed. The main VTC is located at the current site in Houston. A smaller satellite VTC is located in Galveston. The Galveston Center handles all traffic entering and leaving Galveston Bay, Galveston Harbor, and Texas City. Traffic proceeding to Houston is transferred to the Houston Center above Red Fish Bar. Two watchstanders at Houston and one watchstander at Galveston with integrated data workstations and decision aiding software can effectively manage the activity in this port complex. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Centers must

be structured so that such requests are controlled by a bulletin board type interface. One Commanding Officer, one Executive Officer, and a clerk are also required for the proper administration of these facilities. Each center is to employ the following equipment:

3.2.2.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.2.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.2.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.2.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. Two sets of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Houston/Galveston VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware Costs (x $1000)

Vessel Traffic Center, Houston	non-recurring	recurring (10-yr)
VTS Console (2 workstations one supervisory console & all software)	1000	
Recording Equipment	100	
SCADA Equipment (12 radar sites)	500	
Sub-total:	1600	800

Vessel Traffic Center, Galveston	non-recurring	recurring (10-yr)
VTS Console (1 workstation one supervisory console & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (12 radar sites)	200	
Sub-total:	850	400

<u>Sub-Zone I</u>

No new hardware required

<u>Sub-Zone II</u>

No facilities in this sub-zone.
Surveillance coverage from Sub-Zone III

<u>Sub-Zone III</u>

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 3 radar	400	400
1 Module 13 MET	40	5
1 Module 15 hyd	50	5
Sub-total	867	753

<u>Sub-Zone IV</u>

No new hardware required

<u>Sub-Zone V</u>		
1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 met	40	5
Sub-total	369	328
<u>Sub-Zone VI</u>		
1 Module 1 radar	310	310
1 Module 10 VHF	19	13
Sub-total	329	323
<u>Sub-Zone VII</u>		
3 Module 1 radar	930	930
2 Module 10 VHF	38	26
1 Module 11 met	40	5
Sub-total	1008	961
<u>Sub-Zone VIII</u>		
5 Module 1 radar	1550	1550
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 11 met	40	5
Sub-total	1676	1601
HARDWARE TOTALS:	$6699	$5158

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$6700
Management, Engineering, etc. (60%) Assumptions: Turnkey system Procurement by integ. contractor, good manufacturer support, some software provided, System Manual required	4020
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	1340
Spares & Training (10%)	670
Civil Engineering 12 remote radar sites, a new VTC in Galveston, five remote comms and four WX sensors installations, no land acquisition	3000
PROJECT ESTIMATE:	15730
Data Base Management System	300
TOTAL: (non-recurring)	$16030

Recurring (10 year)

Hardware	5158
2 Watchstanders (Houston)	5000
1 Watch Sueprvisor (Houston)	2500
1 Watchstander (Galveston)	2500
1 Supervisor (Galveston)	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$19158
TOTAL 10-YEAR PROJECT COST:	$35188

REFERENCES

1. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands, 21st Edition, NOAA, Washington, D.C.

2. Ibid, Page 66.

3. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C. 22 March 1990.

4. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands, 21st Edition, NOAA, Washington, D.C., p. 242.

5. Final Report, National Vessel Traffic Services Study (TP5965E),Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

6. Title 33, Code of Federal Regulations, Subpart 165.804.

7. Title 33, Code of Federal Regulations, Subpart 110.97.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

COST SAVINGS DERIVED USING EXISTING EQUIPMENT

Hardware Costs (x $1000) (Makes Use of Existing USCG Radar)

Vessel Traffic Center, Houston	non-recurring	recurring(10-yr)
VTS Console (2 workstations one supervisory console & all software)	1000	
Recording Equipment	100	
SCADA Equipment (12 radar sites)	500	
Sub-total:	1600	800

Vessel Traffic Center, Galveston	non-recurring	recurring(10-yr)
VTS Console (1 workstation one supervisory console & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (12 radar sites)	200	
Sub-total:	850	400

Sub-Zone I

1 Module 1 radar	310	310
Sub-total:	310	310

Sub-Zone II

No facilities in this sub-zone.
Surveillance coverage from sub-zone III

Sub-Zone III

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 3 radar	400	400
1 Module 13 MET	40	5
1 Module 15 hyd	50	5
Sub-total:	867	753

Sub-Zone IV

No new hardware required

Sub-Zone V

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 met	40	5
Sub-total:	369	328

Sub-Zone VI

1 Module 1 Radar	310	310
1 Module 10 VHF	19	13
Sub-total:	329	323

Sub-Zone VII

3 Module 1 radar	930	930
2 Module 10 VHF	38	26
1 Module 13 MET	40	5
Sub-total	1008	961

Sub-Zone VIII

5 Module 1 radars	1550	1550
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	1676	1601
HARDWARE TOTALS:	$7009	$5468

Project Totals (x $1000)

Non-recurring

Hardware	$7009
Management, Engineering, etc. (60%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	4205
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	1402
Spares & Training (10%)	701
Civil Engineering 12 remote radar sites, a new VTC in Galveston, five remote comms and four WX sensors installations, no land acquisition	3000
PROJECT ESTIMATE:	16317
Data Base Management System	300
TOTAL: (non-recurring)	$16617

Recurring (10 year)

Hardware	5158
2 Watchstanders (Houston)	5000
1 Watch Supervisor (Houston)	2500
1 Watchstander (Galveston)	2500
1 Supervisor (Galveston)	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$19158
TOTAL 10-YEAR PROJECT COST:	$35475

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I	1																		Existing Radar/Comm Facilities are Sufficient
II																			Radar Coverage from Sub-Zone III
III	1		1							1	1		1		1				
IV																			
V	1									1			1						
VI	1									1									Some Required Coverage is Provided by Radar From Sub-Zone VII
VII	3									2			1						
VIII	5									2	1		1						

PORT OF HOUSTON/GALVESTON, TX SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix G   Zone 7 Houston/Galveston, TX

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone	701A	
2012	A	HOUSTON SHIP CHANNEL, TEX. (HOUSTON, TEX.)
2013	A	DOUBLE BAYOU, TEX.
2015	A	DICKINSON BAYOU, TEX.
2063	A	ANAHUAC CHANNEL, TEX.
2396	A	CHANNEL TO PORT BOLIVAR, TEX.
2400	A	TRINITY RIVER CHANNEL TO LIBERTY, TEX.
2401	A	CEDAR BAYOU, TEX.
2404	A	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)
2417	A	GALVESTON CHANNEL, TEX. (GALVESTON, TEX.)
2426	A	GALVESTON HARBOR, TEX.
6243	A	GULF INTRACOASTAL WATERWAY, SABINE RIVER TO GALVESTON, TEX.(
6244	A	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
Subzone	702E	
2012	A	HOUSTON SHIP CHANNEL, TEX. (HOUSTON, TEX.)
2012	B	HOUSTON SHIP CHANNEL, TEX. (HOUSTON, TEX.)
2013	A	DOUBLE BAYOU, TEX.
2013	B	DOUBLE BAYOU, TEX.
2015	A	DICKINSON BAYOU, TEX.
2015	B	DICKINSON BAYOU, TEX.
2063	A	ANAHUAC CHANNEL, TEX.
2063	B	ANAHUAC CHANNEL, TEX.
2396	A	CHANNEL TO PORT BOLIVAR, TEX.
2400	A	TRINITY RIVER CHANNEL TO LIBERTY, TEX.
2400	B	TRINITY RIVER CHANNEL TO LIBERTY, TEX.
2401	A	CEDAR BAYOU, TEX.
2401	B	CEDAR BAYOU, TEX.
2404	A	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)
2404	B	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)
2417	A	GALVESTON CHANNEL, TEX. (GALVESTON, TEX.)
2417	B	GALVESTON CHANNEL, TEX. (GALVESTON, TEX.)
2426	A	GALVESTON HARBOR, TEX.
2426	B	GALVESTON HARBOR, TEX.
6243	A	GULF INTRACOASTAL WATERWAY, SABINE RIVER TO GALVESTON, TEX.(
6243	B	GULF INTRACOASTAL WATERWAY, SABINE RIVER TO GALVESTON, TEX.(
6244	A	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
6244	B	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
Subzone	703D	
2396	A	CHANNEL TO PORT BOLIVAR, TEX.
2404	A	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)
2404	B	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)
2426	A	GALVESTON HARBOR, TEX.
2426	B	GALVESTON HARBOR, TEX.
6244	A	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
6244	B	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 701A Galveston Approach

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	14,219,986	0	802,687	0	15,022,673
2	FOREST PRODUCTS	58,020	0	0	0	58,020
3	FISHERIES PRODUCTS	4,774	0	0	0	4,774
4	MINING PRODUCTS, NEC	1,611,256	0	4,413,155	0	6,024,411
5	PROC. FOODS & MFTRS, NEC	21,113,218	0	28,573,393	0	49,686,611
6	WASTE OF MANUFACTURING	309,336	0	3,040,282	0	3,349,618
1311	CRUDE PETROLEUM	0	43,785,663	0	12,419,900	56,205,563
1492	SULPHUR, DRY	957,230	0	0	0	957,230
1493	SULPHUR, LIQUID	0	1,143,171	0	600,315	1,743,486
2810	SODIUM HYDROXIDE (CAUSTI	20	0	488,132	0	488,152
2811	CRUDE PROD-COAL TAR-PET	201,465	0	471,271	0	672,736
2813	ALCOHOLS	0	1,551,254	0	4,896,259	6,447,513
2817	BENZENE AND TOLUENE	0	894,585	0	7,945,544	8,840,129
2818	SULPHURIC ACID	272	0	0	683,877	684,149
2871	NITROGEN CHEM FERTILIZER	15,493	106,435	5,700	552,270	679,898
2872	POTASSIC CHEM FERTILIZER	294,480	0	139,595	0	434,075
2873	PHOSPHA CHEM FERTILIZERS	137	0	44,790	0	44,927
2911	GASOLINE, INCL NATURAL	0	5,509,612	0	11,906,127	17,415,739
2912	JET FUEL	0	711,194	0	1,423,050	2,134,244
2913	KEROSENE	0	30,572	0	609,973	640,545
2914	DISTILLATE FUEL OIL	0	2,422,582	0	7,998,157	10,420,739
2915	RESIDUAL FUEL OIL	0	5,594,314	0	21,592,490	27,186,804
2916	LUBRIC OILS-GREASES	0	1,302,907	0	2,711,781	4,014,688
2917	NAPHTHA, PETRLM SOLVENTS	0	1,204,973	0	7,303,733	8,508,706
2921	LIQUI PETR-COAL-NATR GAS	13	1,319,146	0	993,573	2,312,732
	Subzone Total :	38,785,700	65,576,408	37,979,005	81,637,049	223,978,162

Subzone 702E Houston Ship Channel

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	14,219,986	0	802,687	0	15,022,673
2	FOREST PRODUCTS	58,020	0	0	0	58,020
3	FISHERIES PRODUCTS	4,774	0	0	0	4,774
4	MINING PRODUCTS, NEC	1,611,256	0	4,413,155	0	6,024,411
5	PROC. FOODS & MFTRS, NEC	21,113,218	0	28,573,393	0	49,686,611
6	WASTE OF MANUFACTURING	309,336	0	3,040,282	0	3,349,618
1311	CRUDE PETROLEUM	0	43,785,663	0	12,419,900	56,205,563
1492	SULPHUR, DRY	957,230	0	0	0	957,230
1493	SULPHUR, LIQUID	0	1,143,171	0	600,315	1,743,486
2810	SODIUM HYDROXIDE (CAUSTI	20	0	488,132	0	488,152
2811	CRUDE PROD-COAL TAR-PET	201,465	0	471,271	0	672,736
2813	ALCOHOLS	0	1,551,254	0	4,896,259	6,447,513
2817	BENZENE AND TOLUENE	0	894,585	0	7,945,544	8,840,129
2818	SULPHURIC ACID	272	0	0	683,877	684,149
2871	NITROGEN CHEM FERTILIZER	15,493	106,435	5,700	552,270	679,898
2872	POTASSIC CHEM FERTILIZER	294,480	0	139,595	0	434,075
2873	PHOSPHA CHEM FERTILIZERS	137	0	44,790	0	44,927
2911	GASOLINE, INCL NATURAL	0	5,509,612	0	11,906,127	17,415,739
2912	JET FUEL	0	711,194	0	1,423,050	2,134,244
2913	KEROSENE	0	30,572	0	609,973	640,545
2914	DISTILLATE FUEL OIL	0	2,422,582	0	7,998,157	10,420,739
2915	RESIDUAL FUEL OIL	0	5,594,314	0	21,592,490	27,186,804
2916	LUBRIC OILS-GREASES	0	1,302,907	0	2,711,781	4,014,688
2917	NAPHTHA, PETRLM SOLVENTS	0	1,204,973	0	7,303,733	8,508,706
2921	LIQUI PETR-COAL-NATR GAS	13	1,319,146	0	993,573	2,312,732
	Subzone Total :	38,785,700	65,576,408	37,979,005	81,637,049	223,978,162

Appendix G Zone 7 Houston/Galveston, TX 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 703D Galveston and Texas City

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	27,281	0	163,335	0	190,616
3	FISHERIES PRODUCTS	14	0	0	0	14
4	MINING PRODUCTS, NEC	643	0	1,698,967	0	1,699,610
5	PROC. FOODS & MFTRS, NEC	2,276,748	0	8,814,637	0	11,091,385
6	WASTE OF MANUFACTURING	0	0	718,329	0	718,329
1311	CRUDE PETROLEUM	0	20,719,708	0	3,095,723	23,815,431
1492	SULPHUR, DRY	4,630	0	0	0	4,630
1493	SULPHUR, LIQUID	0	0	0	81,711	81,711
2810	SODIUM HYDROXIDE (CAUSTI	0	0	70,120	0	70,120
2811	CRUDE PROD-COAL TAR-PET	24,507	0	321,872	0	346,379
2813	ALCOHOLS	0	329,080	0	1,309,065	1,638,145
2817	BENZENE AND TOLUENE	0	104,778	0	2,591,215	2,695,993
2871	NITROGEN CHEM FERTILIZER	0	9,003	0	152,301	161,304
2872	POTASSIC CHEM FERTILIZER	294,036	0	2,902	0	296,938
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,107	0	2,107
2911	GASOLINE, INCL NATURAL	0	2,318,249	0	3,827,697	6,145,946
2912	JET FUEL	0	2,354	0	226,056	228,410
2913	KEROSENE	0	1,474	0	206,136	207,610
2914	DISTILLATE FUEL OIL	0	590,053	0	1,569,327	2,159,380
2915	RESIDUAL FUEL OIL	0	317,466	0	4,158,813	4,476,279
2916	LUBRIC OILS-GREASES	0	29,750	0	259,567	289,317
2917	NAPHTHA, PETRLM SOLVENTS	0	116,629	0	1,757,256	1,873,885
2921	LIQUI PETR-COAL-NATR GAS	0	3,702	0	22,820	26,522
	Subzone Total :	2,627,859	24,542,246	11,792,269	19,257,687	58,220,061

Appendix G ZONE 7 Houston/Galveston, TX 7/22/91

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 701A				
Passenger	0	0	123	123
Dry Cargo	1,586	8,696	2,439	12,721
Tanker	4,968	4,280	9	9,257
Dry Cargo Barge Tow	77	0	0	77
Tanker Barge Tow	145	0	0	145
Tug/Tow Boat	567	0	0	567
Subzone Total:	7,344	12,976	2,571	22,891
Subzone : 702E				
Passenger	0	0	69,970	69,970
Dry Cargo	1,586	8,696	2,439	12,721
Tanker	4,968	4,280	9	9,257
Dry Cargo Barge Tow	77	0	1,568	1,645
Tanker Barge Tow	145	0	5,520	5,665
Tug/Tow Boat	567	0	3,470	4,038
Subzone Total:	7,344	12,976	82,976	103,296
Subzone : 703D				
Passenger	0	0	323	323
Dry Cargo	875	4,427	2,439	7,741
Tanker	3,344	2,509	9	5,862
Dry Cargo Barge Tow	41	0	1,568	1,609
Tanker Barge Tow	112	0	5,520	5,632
Tug/Tow Boat	515	0	3,470	3,985
Subzone Total:	4,887	6,936	13,329	25,152

Note: Sum of all vessel transits within each study subzone.

Appendix G ZONE 7 Houston/Galveston, TX

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 7 Houston/Galveston, TX

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	69,970	69,970
Dry Cargo	1,586	8,696	7,555	17,837
Tanker	4,968	4,280	958	10,206
Dry Cargo Barge Tow	77	0	7,483	7,560
Tanker Barge Tow	145	0	32,698	32,843
Tug/Tow Boat	567	0	22,420	22,987
Zone Total:	7,344	12,976	141,083	161,403

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix G ZONE 7 Houston/Galveston, TX

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 701A Galveston Approach		
2012	HOUSTON SHIP CHANNEL, TEX. (HOUSTON, TEX.)	3	3
2015	DICKINSON BAYOU, TEX.	3	3
2404	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)	3	3
2417	GALVESTON CHANNEL, TEX. (GALVESTON, TEX.)	3	3
2426	GALVESTON HARBOR, TEX.	3	3
6243	GULF INTRACOASTAL WATERWAY, SABINE RIVER TO GALVESTON, TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
6244	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 702E Houston Ship Channel		
2012	HOUSTON SHIP CHANNEL, TEX. (HOUSTON, TEX.)	3	3
2015	DICKINSON BAYOU, TEX.	3	3
2404	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)	3	3
2417	GALVESTON CHANNEL, TEX. (GALVESTON, TEX.)	3	3
2426	GALVESTON HARBOR, TEX.	3	3
6243	GULF INTRACOASTAL WATERWAY, SABINE RIVER TO GALVESTON, TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
6244	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 703D Galveston and Texas City		
2404	TEXAS CITY CHANNEL, TEX. (TEXAS CITY, TEX.)	3	3
2426	GALVESTON HARBOR, TEX.	3	3
6244	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix G Zone 7 Houston/Galveston, TX

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
702E	Houston Ship Channel	81,088	435.96
703D	Galveston and Texas City	10,699	334.34
	Total for Zone	91,787	95.31

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

TABLE 6.1 Forecast 1995
Vessel **Transits by Subzone**, Vessel **Type, and Size**

Vessel Type	Large	Medium	Small	Total
Subzone : 701A				
Passenger	0	0	129	129
Dry Cargo	1,821	10,112	8,595	20,528
Tanker	5,287	4,256	974	10,517
Dry Cargo Tow	0	0	8,587	8,587
Tanker Tow	148	0	33,992	34,140
Tug/Tow Boat	0	0	12,940	12,940
Subzone Total:	7,256	14,368	65,217	86,842
Subzone : 702E				
Passenger	0	0	73,648	73,648
Dry Cargo	1,821	10,112	8,595	20,528
Tanker	5,287	4,256	974	10,517
Dry Cargo Tow	0	0	8,587	8,587
Tanker Tow	148	0	33,992	34,140
Tug/Tow Boat	0	0	12,940	12,940
Subzone Total:	7,256	14,368	138,736	160,361
Subzone : 703D				
Passenger	0	0	340	340
Dry Cargo	899	4,454	4,851	10,204
Tanker	3,452	2,453	482	6,387
Dry Cargo Tow	0	0	1,985	1,985
Tanker Tow	112	0	8,823	8,935
Tug/Tow Boat	0	0	1,330	1,330
Subzone Total:	4,463	6,907	17,810	29,180

Note: Sum of all vessel transits within each study subzone.

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Appendix G ZONE 7 Houston/**Galveston, TX**

TABLE 6.2 **Forecast** 2000
Vessel Transits by Subzone, **Vessel Type**, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 701A				
Passenger	0	0	136	136
Dry Cargo	2,014	11,240	9,352	22,606
Tanker	5,640	4,494	1,051	11,185
Dry Cargo Tow	0	0	9,354	9,354
Tanker Tow	155	0	35,575	35,730
Tug/Tow Boat	0	0	14,774	14,774
Subzone Total:	7,809	15,734	70,242	93,785
Subzone : 702E				
Passenger	0	0	77,520	77,520
Dry Cargo	2,014	11,240	9,352	22,606
Tanker	5,640	4,494	1,051	11,185
Dry Cargo Tow	0	0	9,354	9,354
Tanker Tow	155	0	35,575	35,730
Tug/Tow Boat	0	0	14,774	14,774
Subzone Total:	7,809	15,734	147,626	171,169
Subzone : 703D				
Passenger	0	0	358	358
Dry Cargo	919	4,474	4,943	10,336
Tanker	3,575	2,472	489	6,536
Dry Cargo Tow	0	0	2,176	2,176
Tanker Tow	115	0	9,232	9,347
Tug/Tow Boat	0	0	1,403	1,403
Subzone Total:	4,609	6,946	18,601	30,156

Note: Sum of all vessel transits within each study subzone.

Appendix G ZONE 7 Houston/Galveston, TX

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 701A				
Passenger	0	0	141	141
Dry Cargo	2,246	12,641	10,260	25,147
Tanker	6,061	4,809	1,153	12,023
Dry Cargo Tow	0	0	10,195	10,195
Tanker Tow	162	0	37,161	37,323
Tug/Tow Boat	0	0	17,026	17,026
Subzone Total:	8,469	17,450	75,935	101,854
Subzone : 702E				
Passenger	0	0	80,232	80,232
Dry Cargo	2,246	12,641	10,260	25,147
Tanker	6,061	4,809	1,153	12,023
Dry Cargo Tow	0	0	10,195	10,195
Tanker Tow	162	0	37,161	37,323
Tug/Tow Boat	0	0	17,026	17,026
Subzone Total:	8,469	17,450	156,026	181,945
Subzone : 703D				
Passenger	0	0	370	370
Dry Cargo	943	4,498	5,025	10,466
Tanker	3,722	2,504	501	6,727
Dry Cargo Tow	0	0	2,387	2,387
Tanker Tow	118	0	9,649	9,767
Tug/Tow Boat	0	0	1,491	1,491
Subzone Total:	4,783	7,002	19,423	31,208

Note: Sum of all vessel transits within each study subzone.

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Appendix G ZONE 7 Houston/Galveston, TX

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 701A				
Passenger	0	0	146	146
Dry Cargo	2,525	14,388	11,383	28,296
Tanker	6,592	5,207	1,282	13,081
Dry Cargo Tow	0	0	11,113	11,113
Tanker Tow	171	0	38,909	39,080
Tug/Tow Boat	0	0	19,832	19,832
Subzone Total:	9,288	19,595	82,666	111,549
Subzone 702E				
Passenger	0	0	83,038	83,038
Dry Cargo	2,525	14,388	11,383	28,296
Tanker	6,592	5,207	1,282	13,081
Dry Cargo Tow	0	0	11,113	11,113
Tanker Tow	171	0	38,909	39,080
Tug/Tow Boat	0	0	19,832	19,832
Subzone Total:	9,288	19,595	165,558	194,441
Subzone : 703D				
Passenger	0	0	383	383
Dry Cargo	971	4,531	5,104	10,606
Tanker	3,909	2,545	516	6,970
Dry Cargo Tow	0	0	2,619	2,619
Tanker Tow	122	0	10,109	10,231
Tug/Tow Boat	0	0	1,606	1,606
Subzone Total:	5,002	7,076	20,337	32,415

Note: Sum of all vessel transits within each study subzone.

Appendix G ZONE 7 Houston/Galveston, TX

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	73,648	73,648
Dry Cargo	1,724	9,552	8,308	19,584
Tanker	5,287	4,256	974	10,517
Dry Cargo Tow	0	0	8,587	8,587
Tanker Tow	148	0	33,992	34,140
Tug/Tow Boat	0	0	12,940	12,940
1995 Zone Total:	7,159	13,808	138,449	159,417
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	77,520	77,520
Dry Cargo	1,830	10,190	8,802	20,822
Tanker	5,640	4,494	1,051	11,185
Dry Cargo Tow	0	0	9,354	9,354
Tanker Tow	155	0	35,575	35,730
Tug/Tow Boat	0	0	14,774	14,774
2000 Zone Total:	7,625	14,684	147,076	169,385
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	80,232	80,232
Dry Cargo	2,029	11,145	9,462	22,636
Tanker	6,061	4,809	1,153	12,023
Dry Cargo Tow	0	0	10,195	10,195
Tanker Tow	162	0	37,161	37,323
Tug/Tow Boat	0	0	17,026	17,026
2005 Zone Total:	8,252	15,954	155,228	179,434
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	83,038	83,038
Dry Cargo	2,266	12,578	10,398	25,242
Tanker	6,592	5,207	1,282	13,081
Dry Cargo Tow	0	0	11,113	11,113
Tanker Tow	171	0	38,909	39,080
Tug/Tow Boat	0	0	19,832	19,832
2010 Zone Total:	9,029	17,785	164,573	191,387

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix G Zone 7 Houston/Galveston, TX 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 701A Galveston Approach						
Other	Small	0	2	0	0	2
Subzone Totals:		0	2	0	0	2
Subzone: 702E Houston Ship Channel						
Passenger	Small	3	0	0	0	3
Dry Cargo	Large	10	1	5	0	16
Dry Cargo	Medium	11	2	4	0	17
Tanker	Large	8	1	6	0	15
Tanker	Medium	2	0	3	0	5
Dry Cargo Barge Tow	Small	5	0	15	0	20
Tanker Barge Tow	Small	14	4	30	0	48
Tug/Tow Boat	Small	1	0	7	0	8
Fishing	Small	0	0	1	0	1
Other	Small	4	0	0	0	4
Subzone Totals:		58	8	71	0	137
Subzone: 703D Galveston and Texas City						
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	0	4	1	6
Tanker Barge Tow	Small	2	2	11	1	16
Tug/Tow Boat	Small	1	0	5	0	6
Other	Small	2	0	1	0	3
Subzone Totals:		6	2	22	2	32
Zone Totals:		64	12	93	2	171

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE G-8 ZONE 7, HOUSTON/GALVESTON, TX - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0701A	I	I	I	I	I	I	I	I	I	I	I	I	I				III
0702E	II	II	II	II	II	II	II	II	II	II	II	II	II				III
0703D	II	II	II	II	II	II	II	II	II	II	II	II	II				III

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

APPENDIX TABLE G-9 ZONE 7, HOUSTON/GALVESTON, TX - CANDIDATE VTS DESIGN - 1995-2010

UNITS		
11	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
1	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
7	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
4	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix G Zone 7 Houston/Galveston, TX

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	3.45	.49	2.78	6.72
Dry Cargo	Large	1.71	.26	1.79	3.77
Dry Cargo	Medium	3.78	.55	1.27	5.61
Dry Cargo	Small	.34	.04	.05	.42
Tanker	Large	10.36	2.18	12.08	24.62
Tanker	Medium	1.02	.09	.53	1.63
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	1.66	.48	.54	2.68
Tanker Barge Tow	Large	.10	.04	.06	.20
Tanker Barge Tow	Small	5.32	.89	2.92	9.13
Tug/Tow Boat	Small	.00	.00	.00	.00
		27.73	5.02	22.02	54.78

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	3,320	468	1,846	5,634
Dry Cargo	Large	2,396	497	568	3,461
Dry Cargo	Medium	5,729	1,101	385	7,215
Dry Cargo	Small	259	29	33	321
Tanker	Large	75,097	16,366	50,872	142,334
Tanker	Medium	2,616	242	377	3,235
Tanker	Small	1	0	0	1
Dry Cargo Barge T	Small	93	76	9	178
Tanker Barge Tow	Large	1,334	572	488	2,394
Tanker Barge Tow	Small	34,432	5,789	3,123	43,344
Tug/Tow Boat	Small	0	0	0	0
		125,279	25,140	57,700	208,119

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix G Zone 7 Houston/Galveston, TX

TABLE 10B Avoided Vessel Casualties 1996 - 2010 7/31/91
Existing VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	2.72	.45	2.45	5.63
Dry Cargo	Large	1.33	.26	1.64	3.22
Dry Cargo	Medium	2.94	.53	1.16	4.64
Dry Cargo	Small	.26	.03	.04	.34
Tanker	Large	8.06	2.11	11.04	21.21
Tanker	Medium	.79	.08	.48	1.36
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	1.31	.44	.48	2.23
Tanker Barge Tow	Large	.08	.04	.05	.17
Tanker Barge Tow	Small	4.19	.82	2.58	7.59
Tug/Tow Boat	Small	.00	.00	.00	.00
		21.69	4.77	19.93	46.39

Undiscounted Total Dollar Losses (1.000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	2,618	431	1,629	4,677
Dry Cargo	Large	1,865	480	519	2,865
Dry Cargo	Medium	4,459	1,064	352	5,875
Dry Cargo	Small	203	27	29	258
Tanker	Large	58,680	15,851	46,830	121,361
Tanker	Medium	2,043	234	346	2,622
Tanker	Small	1	0	0	1
Dry Cargo Barge T	Small	73	70	8	151
Tanker Barge Tow	Large	1,045	555	450	2,050
Tanker Barge Tow	Small	27,155	5,334	2,757	35,246
Tug/Tow Boat	Small	0	0	0	0
		98,142	24,046	52,919	175,107

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.22	.03	.18	.43
Dry Cargo	Large	.21	.03	.22	.47
Dry Cargo	Medium	.47	.07	.16	.70
Dry Cargo	Small	.02	.00	.00	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.95	.14	.57	1.66
Candidate VTS Design - Dollars					
Passenger	Small	331,410.59	47,262.31	266,765.70	645,438.60
Dry Cargo	Large	321,913.29	49,688.63	336,855.74	708,457.66
Dry Cargo	Medium	711,799.29	104,071.22	239,372.46	1,055,242.96
Dry Cargo	Small	32,211.94	3,504.27	4,636.36	40,352.56
Tanker	Small	3.29	0.00	2.12	5.41
Dry Cargo Barge Tow	Small	5,477.09	1,583.03	1,791.81	8,851.93
Tanker Barge Tow	Small	17,580.98	2,932.61	9,662.47	30,176.06
Tug/Tow Boat	Small	.02	.01	.01	.03
Totals		1,420,396.48	209,042.07	859,086.67	2,488,525.22
Existing VTS Design - Counts					
Passenger	Small	.17	.03	.16	.36
Dry Cargo	Large	.17	.03	.21	.40
Dry Cargo	Medium	.37	.07	.15	.58
Dry Cargo	Small	.02	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.74	.13	.52	1.39
Existing VTS Design - Dollars					
Passenger	Small	261,300.33	43,530.62	235,361.57	540,192.52
Dry Cargo	Large	250,541.34	47,982.70	307,887.90	606,411.95
Dry Cargo	Medium	553,966.95	100,495.83	218,775.57	873,238.34
Dry Cargo	Small	25,183.09	3,209.70	4,030.96	32,423.75
Tanker	Small	2.57	0.00	1.85	4.42
Dry Cargo Barge Tow	Small	4,318.47	1,458.05	1,580.92	7,357.45
Tanker Barge Tow	Small	13,861.93	2,701.09	8,525.22	25,088.24
Tug/Tow Boat	Small	.01	.00	.01	.03
Totals		1,109,174.69	199,378.00	776,164.01	2,084,716.70

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	2.62	.37	2.11	5.10
Dry Cargo	Large	.02	.00	.02	.05
Dry Cargo	Medium	.05	.01	.02	.08
Dry Cargo	Small	.25	.03	.04	.32
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.04	.01	.01	.06
Tanker Barge Tow	Small	.13	.02	.07	.22
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		3.12	.45	2.27	5.83
Candidate VTS Design - Dollars					
Passenger	Small	624,051.64	88,995.72	502,324.25	1,215,371.61
Dry Cargo	Large	5,527.17	853.14	5,783.73	12,164.03
Dry Cargo	Medium	12,221.41	1,786.88	4,109.96	18,118.25
Dry Cargo	Small	60,655.61	6,598.60	8,730.33	75,984.55
Tanker	Small	5.74	0.00	3.71	9.46
Dry Cargo Barge Tow	Small	9,570.19	2,766.05	3,130.86	15,467.10
Tanker Barge Tow	Small	30,719.49	5,124.18	16,883.37	52,727.05
Tug/Tow Boat	Small	.03	.01	.02	.05
Totals		742,751.29	106,124.57	540,966.23	1,389,842.09
Existing VTS Design - Counts					
Passenger	Small	2.07	.34	1.86	4.27
Dry Cargo	Large	.02	.00	.02	.04
Dry Cargo	Medium	.04	.01	.02	.06
Dry Cargo	Small	.20	.03	.03	.26
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.01	.05
Tanker Barge Tow	Small	.10	.02	.06	.18
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		2.46	.41	2.00	4.87
Existing VTS Design - Dollars					
Passenger	Small	492,032.86	81,968.88	443,189.75	1,017,191.49
Dry Cargo	Large	4,301.73	823.85	5,286.36	10,411.94
Dry Cargo	Medium	9,511.47	1,725.49	3,756.32	14,993.28
Dry Cargo	Small	47,420.17	6,043.93	7,590.36	61,054.46
Tanker	Small	4.49	0.00	3.23	7.72
Dry Cargo Barge Tow	Small	7,545.73	2,547.67	2,762.37	12,855.77
Tanker Barge Tow	Small	24,221.14	4,719.64	14,896.25	43,837.03
Tug/Tow Boat	Small	.02	.01	.01	.04
Totals		585,037.61	97,829.47	477,484.64	1,160,351.72

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	2.94	.33	.87	4.15
Dry Cargo	Large	1.27	.19	.17	1.63
Dry Cargo	Medium	2.81	.39	.12	3.32
Dry Cargo	Small	.29	.03	.03	.34
Tanker	Large	7.82	1.75	1.58	11.15
Tanker	Medium	.77	.07	.07	.91
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	1.26	.20	.08	1.54
Tanker Barge Tow	Large	.09	.02	.01	.12
Tanker Barge Tow	Small	4.06	.37	.41	4.84
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		21.31	3.35	3.35	28.00
Candidate VTS Design - Dollars					
Passenger	Small	1,002,643.18	111,760.26	447,190.29	1,561,593.73
Dry Cargo	Large	935,659.68	138,212.23	103,734.50	1,177,606.41
Dry Cargo	Medium	2,499,431.16	349,723.38	55,112.65	2,904,267.19
Dry Cargo	Small	54,573.20	4,827.50	6,493.16	65,893.87
Tanker	Large	6,147,328.88	1,372,043.57	3,411,555.02	10,930,927.47
Tanker	Medium	509,179.32	46,078.61	124,122.87	679,380.81
Tanker	Small	65.15	0.00	54.90	120.06
Dry Cargo Barge Tow	Small	73,406.72	11,748.08	3,834.32	88,989.12
Tanker Barge Tow	Large	15,002.17	3,510.47	2,230.74	20,743.38
Tanker Barge Tow	Small	287,871.64	26,588.98	36,734.04	351,194.67
Tug/Tow Boat	Small	.06	.01	.04	.11
Totals		11,525,161.17	2,064,493.09	4,191,062.54	17,780,716.81
Existing VTS Design - Counts					
Passenger	Small	2.32	.30	.77	3.39
Dry Cargo	Large	.99	.18	.16	1.33
Dry Cargo	Medium	2.18	.38	.11	2.68
Dry Cargo	Small	.22	.02	.02	.27
Tanker	Large	6.09	1.69	1.45	9.22
Tanker	Medium	.60	.07	.06	.73
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	1.00	.19	.07	1.25
Tanker Barge Tow	Large	.07	.02	.01	.10
Tanker Barge Tow	Small	3.20	.35	.36	3.90
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		16.67	3.19	3.01	22.88
Existing VTS Design - Dollars					
Passenger	Small	790,532.96	102,936.00	394,546.26	1,288,015.22
Dry Cargo	Large	728,212.98	133,467.07	94,813.87	956,493.92
Dry Cargo	Medium	1,945,214.43	337,708.57	50,370.46	2,333,293.46
Dry Cargo	Small	42,664.98	4,421.71	5,645.31	52,732.00
Tanker	Large	4,784,812.04	1,325,021.55	3,118,640.40	9,228,473.99
Tanker	Medium	396,302.52	44,497.77	113,455.85	554,256.14
Tanker	Small	50.94	0.00	47.74	98.67
Dry Cargo Barge Tow	Small	57,878.38	10,820.60	3,383.03	72,082.01
Tanker Barge Tow	Large	11,697.36	3,394.43	2,045.23	17,137.02
Tanker Barge Tow	Small	226,975.72	24,489.85	32,410.55	283,876.12
Tug/Tow Boat	Small	.05	.01	.03	.09
Totals		8,984,342.33	1,986,757.56	3,815,358.74	14,786,458.64

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.72	.08	.24	1.05
Dry Cargo	Large	.46	.09	.16	.71
Dry Cargo	Medium	1.01	.19	.12	1.32
Dry Cargo	Small	.11	.01	.01	.13
Tanker	Large	2.80	.61	1.17	4.59
Tanker	Medium	.28	.02	.05	.35
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.23	.07	.03	.33
Tanker Tow	Large	.01	.00	.00	.02
Tanker Tow	Small	.75	.12	.17	1.04
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		6.36	1.21	1.96	9.53
Candidate VTS Design - Dollars					
Passenger	Small	2,535.61	282.63	1,009.92	3,828.16
Dry Cargo	Large	4,817.27	1,053.47	476.69	6,347.42
Dry Cargo	Medium	10,651.72	2,206.45	338.74	13,196.91
Dry Cargo	Small	247.67	21.91	29.15	298.72
Tanker	Large	148,004.28	31,550.60	136,081.12	315,636.00
Tanker	Medium	3,818.52	340.99	631.99	4,791.51
Tanker	Small	.81	0.00	.33	1.13
Tanker Tow	Large	2,881.85	1,226.08	1,518.50	5,626.43
Tanker Tow	Small	79,581.32	13,274.61	17,815.05	110,670.97
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		252,539.05	49,956.74	157,901.47	460,397.26
Existing VTS Design - Counts					
Passenger	Small	.57	.08	.21	.86
Dry Cargo	Large	.36	.09	.15	.59
Dry Cargo	Medium	.78	.18	.11	1.08
Dry Cargo	Small	.08	.01	.01	.10
Tanker	Large	2.18	.59	1.07	3.84
Tanker	Medium	.21	.02	.05	.28
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.18	.06	.03	.27
Tanker Tow	Large	.01	.00	.00	.01
Tanker Tow	Small	.59	.12	.15	.85
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		4.96	1.16	1.78	7.90
Existing VTS Design - Dollars					
Passenger	Small	1,999.20	260.31	891.03	3,150.54
Dry Cargo	Large	3,749.23	1,017.30	435.69	5,202.22
Dry Cargo	Medium	8,289.84	2,130.65	309.59	10,730.08
Dry Cargo	Small	193.63	20.07	25.34	239.03
Tanker	Large	125,082.68	33,051.76	137,311.12	295,445.57
Tanker	Medium	3,046.94	337.23	621.05	4,005.23
Tanker	Small	.68	0.00	.30	.98
Tanker Tow	Large	2,487.96	1,312.68	1,541.30	5,341.93
Tanker Tow	Small	69,475.07	13,537.66	17,400.68	100,413.41
Tug/Tow Boat	Small	-.00	-.00	-.00	-.00
Totals		214,325.23	51,667.66	158,536.11	424,528.99

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.06	.02	.07
Dry Cargo	Large	0.00	.03	.01	.04
Dry Cargo	Medium	0.00	.06	.01	.07
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.25	.07	.32
Tanker	Medium	0.00	.01	.00	.01
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.05	.00	.06
Tanker Barge Tow	Large	0.00	.00	.00	.01
Tanker Barge Tow	Small	0.00	.10	.02	.12
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.57	.13	.70
Candidate VTS Design - Dollars					
Passenger	Small	0.00	317.75	89.78	407.53
Dry Cargo	Large	0.00	170.52	57.87	228.39
Dry Cargo	Medium	0.00	357.15	41.12	398.27
Dry Cargo	Small	0.00	23.56	1.56	25.12
Tanker	Large	0.00	1,408.55	390.46	1,799.01
Tanker	Medium	0.00	56.18	17.03	73.21
Tanker	Small	0.00	0.00	.02	.02
Dry Cargo Barge Tow	Small	0.00	309.14	17.52	326.66
Tanker Barge Tow	Large	0.00	27.82	1.81	29.62
Tanker Barge Tow	Small	0.00	572.70	94.46	667.16
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	3,243.36	711.64	3,954.99
Existing VTS Design - Counts					
Passenger	Small	0.00	.05	.01	.07
Dry Cargo	Large	0.00	.03	.01	.04
Dry Cargo	Medium	0.00	.06	.01	.07
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.24	.06	.30
Tanker	Medium	0.00	.01	.00	.01
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.05	.00	.05
Tanker Barge Tow	Large	0.00	.00	.00	.01
Tanker Barge Tow	Small	0.00	.09	.01	.11
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.54	.11	.66
Existing VTS Design - Dollars					
Passenger	Small	0.00	292.66	79.21	371.87
Dry Cargo	Large	0.00	164.66	52.89	217.56
Dry Cargo	Medium	0.00	344.88	37.59	382.46
Dry Cargo	Small	0.00	21.58	1.36	22.94
Tanker	Large	0.00	1,360.28	356.94	1,717.21
Tanker	Medium	0.00	54.25	15.57	69.82
Tanker	Small	0.00	0.00	.02	.02
Dry Cargo Barge Tow	Small	0.00	284.74	15.46	300.19
Tanker Barge Tow	Large	0.00	26.90	1.66	28.55
Tanker Barge Tow	Small	0.00	527.48	83.34	610.83
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	3,077.42	644.03	3,721.45

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.03	0.00	.04
Dry Cargo	Large	0.00	.03	0.00	.03
Dry Cargo	Medium	0.00	.06	0.00	.06
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.25	0.00	.25
Tanker	Medium	0.00	.01	0.00	.01
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.03	0.00	.03
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.01	.06	0.00	.06
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.01	.48	0.00	.49
Candidate VTS Design - Dollars					
Passenger	Small	9,602.24	61,572.22	0.00	71,174.46
Dry Cargo	Large	0.00	60,987.53	0.00	60,987.53
Dry Cargo	Medium	0.00	127,729.98	0.00	127,729.98
Dry Cargo	Small	923.97	4,509.96	0.00	5,433.93
Tanker	Large	0.00	503,848.11	0.00	503,848.11
Tanker	Medium	0.00	20,094.76	0.00	20,094.76
Tanker	Small	2.74	0.00	0.00	2.74
Dry Cargo Barge Tow	Small	4,609.65	59,906.29	0.00	64,515.94
Tanker Barge Tow	Large	0.00	9,977.03	0.00	9,977.03
Tanker Barge Tow	Small	14,796.59	110,978.21	0.00	125,774.80
Tug/Tow Boat	Small	.01	.19	0.00	.20
Totals		29,935.21	959,604.28	0.00	989,539.50
Existing VTS Design - Counts					
Passenger	Small	.00	.03	0.00	.03
Dry Cargo	Large	0.00	.03	0.00	.03
Dry Cargo	Medium	0.00	.06	0.00	.06
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.24	0.00	.24
Tanker	Medium	0.00	.01	0.00	.01
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.03	0.00	.03
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.01	.05	0.00	.06
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.01	.46	0.00	.47
Existing VTS Design - Dollars					
Passenger	Small	7,571.00	56,711.25	0.00	64,282.25
Dry Cargo	Large	0.00	59,293.44	0.00	59,293.44
Dry Cargo	Medium	0.00	124,181.93	0.00	124,181.93
Dry Cargo	Small	728.51	4,153.91	0.00	4,882.42
Tanker	Large	0.00	489,852.33	0.00	489,852.33
Tanker	Medium	0.00	19,536.58	0.00	19,536.58
Tanker	Small	2.16	0.00	0.00	2.16
Dry Cargo Barge Tow	Small	3,634.54	55,176.84	0.00	58,811.38
Tanker Barge Tow	Large	0.00	9,699.89	0.00	9,699.89
Tanker Barge Tow	Small	11,666.55	102,216.77	0.00	113,883.31
Tug/Tow Boat	Small	.01	.18	0.00	.19
Totals		23,602.76	920,823.11	0.00	944,425.88

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix G Zone 7 Houston/Galveston, TX
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
SULPHUR, LIQUID	0.00	.02	.03	.00	.05
BENZENE AND TOLUENE	.00	.09	.20	.18	.47
ALCOHOLS	.00	.10	.19	.31	.61
KEROSENE	.00	.00	.00	.00	.01
JET FUEL	.00	.01	.02	.00	.02
DISTILLATE FUEL OIL	.01	.03	.07	.99	1.10
GASOLINE, INCL NATURAL	.02	.05	.14	.00	.21
RESIDUAL FUEL OIL	.02	.07	1.43	3.05	4.57
CRUDE PETROLEUM	.17	.31	.09	.05	.62
	.21	.68	2.18	4.59	7.67
Existing Vts Design - Counts					
SULPHUR, LIQUID	0.00	.02	.03	.00	.05
BENZENE AND TOLUENE	.00	.08	.16	.15	.39
ALCOHOLS	.00	.08	.16	.27	.51
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.02
DISTILLATE FUEL OIL	.01	.02	.06	.82	.91
GASOLINE, INCL NATURAL	.01	.04	.11	.00	.17
RESIDUAL FUEL OIL	.02	.06	1.18	2.50	3.75
CRUDE PETROLEUM	.14	.27	.07	.04	.52
	.18	.57	1.79	3.78	6.33

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix G Zone 7 Houston/Galveston, TX
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,030	0	0
1996	0	1,508	10,150
1997	0	1,371	9,313
1998	0	1,246	8,545
1999	0	1,133	7,841
2000	0	1,030	7,195
2001	0	936	6,610
2002	0	851	6,073
2003	0	774	5,580
2004	0	703	5,126
2005	0	640	4,710
2006	0	581	4,338
2007	0	529	3,995
2008	0	480	3,679
2009	0	437	3,387
2010	0	397	3,119
	16,030	12,616	89,661

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,030	0	0
1996	0	1,916	12,896
1997	0	1,916	13,015
1998	0	1,916	13,137
1999	0	1,916	13,259
2000	0	1,916	13,384
2001	0	1,916	13,525
2002	0	1,916	13,669
2003	0	1,916	13,814
2004	0	1,916	13,961
2005	0	1,916	14,110
2006	0	1,916	14,294
2007	0	1,916	14,480
2008	0	1,916	14,668
2009	0	1,916	14,857
2010	0	1,916	15,049
	16,030	28,737	208,119

Appendix G TABLE 18B

Zone 7 Houston/Galveston, TX
Annual Benefit & Cost Streams
Existing VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	2,204	8,543
1997	0	2,004	7,838
1998	0	1,821	7,192
1999	0	1,656	6,598
2000	0	1,505	6,055
2001	0	1,368	5,562
2002	0	1,244	5,110
2003	0	1,131	4,695
2004	0	1,028	4,313
2005	0	935	3,963
2006	0	850	3,649
2007	0	772	3,360
2008	0	702	3,094
2009	0	638	2,849
2010	0	580	2,624
	0	18,439	75,445

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	2,800	10,854
1997	0	2,800	10,954
1998	0	2,800	11,056
1999	0	2,800	11,158
2000	0	2,800	11,263
2001	0	2,800	11,381
2002	0	2,800	11,501
2003	0	2,800	11,623
2004	0	2,800	11,746
2005	0	2,800	11,871
2006	0	2,800	12,025
2007	0	2,800	12,181
2008	0	2,800	12,339
2009	0	2,800	12,497
2010	0	2,800	12,658
	0	42,000	175,107

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0701	102	1	Alewife	.0010	.0010	.0010	.0010
0701	102	3	Atlantic Stingray	0.0000	0.0000	0.0000	0.0000
0701	102	3	Gulf Menhaden	0.0000	0.0000	0.0000	0.0000
0701	102	5	Gulf Butterfish	.0987	.0987	.1585	.0493
0701	102	33	Spanish Mackerel	.0316	.0316	.0316	.0316
0701	102	42	Scaled Sardine	.0052	.0052	.0052	.0052
0701	102	43	Atlantic Thread Herring	.0052	.0052	.0052	.0052
0701	102	43	Bay Anchovy	.0052	.0052	.0052	.0052
0701	102	43	Striped Anchovy	.0052	.0052	.0052	.0052
0701	102	44	Striped Mullet	.9700	.9700	.9700	.9700
0701	102	128	Searobins (all)	.1316	.0789	.0329	.0316
0701	102	130	Planehead Filefish	0.0000	.0316	.0316	0.0000
0701	102	238	Gulf Menhaden	.0974	.0974	.0974	.0316
0701	103	8	Bluefish	.4800	.0070	.4800	.8600
0701	103	11	Silver Sea Trout	9.3749	3.4375	1.8749	2.4999
0701	103	11	Weakfish	.0015	.0015	.0015	.0015
0701	103	50	Bonito	.0300	.0300	.0300	.0300
0701	103	51	Jack	.0070	.0070	.0070	.0070
0701	103	52	Amberjack	.0300	.0300	.0300	.0300
0701	103	54	Blue Runner	.0070	.0070	.0070	.0070
0701	103	55	Doulphin	.0030	.0060	.0030	.0030
0701	104	12	Tuna	.0080	.0080	.0080	.0080
0701	104	13	Swordfish	.0280	.0280	.0280	.0280
0701	104	14	Shark	.0100	.0100	.0100	.0100
0701	105	17	Summer Flounder	.0380	.2500	.2100	.2300
0701	105	56	Lefteye Flounders (all)	.6414	.6414	1.2828	.6414
0701	105	57	Bay Wiff	.0535	.0802	.1604	.0535
0701	105	57	Fringed Flounder	.1604	.1604	.6416	.1604
0701	105	57	Gulf Flounder	.1604	.1604	.1604	.1604
0701	105	57	Ocellated Flounder	.1604	.1604	.1604	.1604
0701	105	57	Shoal Flounder	.4440	.4440	1.7776	.4440
0701	105	237	Lesser Electric Ray	0.0000	0.0000	0.0000	0.0000
0701	105	237	Smooth Butterfly Ray	.2388	.2388	.2388	.2388
0701	105	242	Lined Sole	.1539	.1539	.1539	.1539
0701	106		Silver Perch	0.0000	0.0000	0.0000	0.0000
0701	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
0701	106	28	Tilefish	.0390	.0390	.0390	.0390
0701	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
0701	106	34	Harvestfish	.0118	.0327	.0454	.0237
0701	106	35	Atlantic Croaker	3.6925	3.6925	1.8463	.1282
0701	106	36	Banded Drum	.0989	.1578	.0789	.0789
0701	106	36	Star Drum	.2368	.7105	3.5526	.8881
0701	106	37	Spot	.7895	.1974	.0592	.2960
0701	106	40	B'ack Edge Cusk Eel	0.0000	0.0000	0.0000	0.0000
0701	106	40	Eels	.0011	.0011	.0011	.0011
0701	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
0701	106	47	Sand Sea Trout	.1745	3.1429	.9375	.7498
0701	106	48	Gafftopsail Catfish	.2130	.2130	.2130	.2130
0701	106	48	Hardhead Catfish	.3195	.4440	.2220	.1065
0701	106	60	Longspine Porgy	.3191	.3191	1.2763	1.9143
0701	106	60	Porgies	.2000	.2000	.2000	.2000
0701	106	61	Florida Pompano	.0070	.0070	.0011	.0070
0701	106	62	Grunt	.0120	.0120	.0120	.0120

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0701	106	63	Pinfish	.1053	.0329	.0329	0.0000
0701	106	64	Southern Kingfish	.0395	.0658	.9867	.2959
0701	106	69	Red Snapper	0.0000	.2866	0.0000	0.0000
0701	106	71	Gulf Hake	0.0000	0.0000	0.0000	0.0000
0701	106	71	Southern Hake	0.0000	0.0000	0.0000	.0316
0701	106	71	Spotted Hake	0.0000	0.0000	0.0000	0.0000
0701	106	76	Black ear Bass	0.0000	0.0000	0.0000	0.0000
0701	106	76	Rock Sea Bass	.0427	.0342	.0427	.0513
0701	106	76	Sea Bass	.0427	.0342	.0342	.0513
0701	106	77	Gray Triggerfish	0.0000	0.0000	0.0000	0.0000
0701	106	131	Rough Scad	0.0000	0.0000	0.0000	0.0000
0701	106	132	Singlefoot Frogfish	0.0000	0.0000	0.0000	0.0000
0701	106	133	Other Batfish	.0329	.0329	.0394	.0329
0701	106	133	Pancake Batfish	0.0000	0.0000	0.0000	0.0000
0701	106	134	Inshore Lizardfish	.0631	.0316	.0421	0.0000
0701	106	135	Atlantic Medshipmen	0.0000	.0197	.0118	0.0000
0701	106	239	Atlantic Bumper	.0189	1.1842	.0189	0.0000
0701	106	240	Atlantic Moonfish	.0553	.0189	.0711	0.0000
0701	106	241	Pigfish	.0329	.0329	.0974	0.0000
0701	106	243	Hog Choker	0.0000	.0316	0.0000	.0316
0701	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
0701	108	25	Brown Shrimp	.0050	.0050	.0026	0.0000
0701	108	25	Pink Shrimp	.0016	0.0000	.0020	.0020
0701	108	25	White Shrimp	.0079	.0122	.0592	.0148
0701	108	209	Blue Crab	.0040	.0040	.0020	.0040
0701	108	217	Crabs , Other	.0010	.0010	.0010	.0010
0701	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
0701	108	234	Rock Shrimp	0.0000	0.0000	0.0000	0.0000
0701	108	236	Seabob Shrimp	0.0000	.0032	.0013	0.0000
0701	108	298	Other Shrimp	.0024	.0008	.0024	.0032
0701	109	207	Squid	.0083	.0830	.0830	.0083
0702	102	3	Gulf Menhaden	2.0300	3.5000	3.5000	2.0300
0702	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0702	105	17	Summer Flounder	.0380	.2500	.2100	.2300
0702	105	56	Southern Flounder	.6300	.6300	.6300	.6300
0702	106	35	Atlantic Croaker	10.5000	20.5000	20.5000	10.5000
0702	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0702	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0702	106	45	Sheepshead	.0300	.0300	.0300	.0300
0702	106	46	Spotted Sea Trout	1.2000	1.2000	1.2000	1.2000
0702	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0702	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0702	106	58	Red Drum	.7800	.7800	.7800	.7800
0702	106	59	Black Drum	.4500	.4500	.4500	.4500
0702	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0702	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
0702	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0702	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0702	108	209	Blue Crab	.0360	.1200	.0360	.0080
0702	108	215	Shrimp - White, Pink, Brn	13.6180	16.3500	15.5400	13.6180
0703	102	3	Gulf Menhaden	2.0300	3.5000	3.5000	2.0300
0703	102	44	Stripped Mullet	.9700	.9700	.9700	.9700
0703	105	17	Summer Flounder	.0380	.2500	.2100	.2300

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0703	105	56	Southern Flounder	.6300	.6300	.6300	.6300
0703	106	35	Atlantic Croaker	10.5000	20.5000	20.5000	10.5000
0703	106	36	Drum	1.1000	1.1000	1.1000	0.0000
0703	106	37	Spot	4.5000	4.5000	4.5000	4.5000
0703	106	45	Sheepshead	.0300	.0300	.0300	.0300
0703	106	46	Spotted Sea Trout	1.2000	1.2000	1.2000	1.2000
0703	106	47	Sand Seatrout	2.4300	2.4300	2.4300	2.4300
0703	106	48	Hardhead Catfish	3.0600	3.0600	3.0600	3.0600
0703	106	58	Red Drum	.7800	.7800	.7800	.7800
0703	106	59	Black Drum	.4500	.4500	.4500	.4500
0703	106	63	Pinfish	4.0500	4.0500	4.0500	4.0500
0703	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
0703	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
0703	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
0703	108	209	Blue Crab	.0360	.1200	.0360	.0080
0703	108	215	Shrimp - White, Pink, Brn	13.6180	16.3500	15.5400	13.6180

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0701	202	1033		.1000	5.0000	0.0000	0.0000
0701	202	1042		100.0000	10.0000	1.0000	10.0000
0701	202	1043		0.0000	1.0000	1.0000	0.0000
0701	203	1199		2.1000	2.0000	.1000	0.0000
0701	204	1136		.1000	0.0000	0.0000	0.0000
0701	204	1199		2.1000	0.0000	0.0000	0.0000
0701	205	1199		.5000	1.0000	.1000	1.0000
0701	206	1035		10.0000	10.0000	1.0000	1.0000
0701	206	1068		.1000	.1000	0.0000	1.0000
0701	206	1120		.1000	0.0000	0.0000	.1000
0701	207	1199		2.0000	20.0000	2.0000	0.0000
0701	208	1199		.0016	.0042	0.0000	0.0000
0702	202	1003		.0366	0.0000	.0732	1.2627
0702	202	1043		53.0700	311.1000	2.1960	4.0260
0702	202	1121		.0366	.0092	.0183	0.0000
0702	202	1127		.1281	.0366	.2196	.0366
0702	202	1244		.0549	.0183	0.0000	.0915
0702	203	1199		12.2000	11.6000	.5500	0.0000
0702	205	1199		5.0000	5.8000	.5800	5.8000
0702	205	1242		.2562	.3660	0.0000	0.0000
0702	206	1036		.0275	.0458	0.0000	.0183
0702	206	1046		.2288	.2379	0.0000	0.0000
0702	206	1063		0.0000	0.0000	0.0000	1.0065
0702	206	1073		.0183	0.0000	0.0000	0.0000
0702	206	1073		.4941	2.0130	0.0000	.0092
0702	206	1120		.0092	.1830	.0092	.0183
0702	206	1120		.2013	.4941	.0366	.0732
0702	206	1120		.2745	.0549	.0366	.0732
0702	206	1199		0.0000	0.0000	0.0000	.0366
0702	206	1199		0.0000	0.0000	.0183	0.0000
0702	206	1199		0.0000	.0366	0.0000	0.0000
0702	206	1199		.0183	.0092	.0092	.0366
0702	206	1199		.0915	.4750	0.0000	0.0000
0702	206	1245		.0366	0.0000	0.0000	.0549
0702	207	1199		20.0000	200.0000	20.0000	0.0000
0702	208	1199		.0016	.0042	0.0000	0.0000
0703	202	1003		.0366	0.0000	.0732	1.2627
0703	202	1043		53.0700	311.1000	2.1960	4.0260
0703	202	1121		.0366	.0092	.0183	0.0000
0703	202	1127		.1281	.0366	.2196	.0366
0703	202	1244		.0549	.0183	0.0000	.0915
0703	203	1199		12.2000	11.6000	.5500	0.0000
0703	205	1199		5.0000	5.8000	.5800	5.8000
0703	205	1242		.2562	.3660	0.0000	0.0000
0703	206	1036		.0275	.0458	0.0000	.0183
0703	206	1046		.2288	.2379	0.0000	0.0000
0703	206	1063		0.0000	0.0000	0.0000	1.0065
0703	206	1073		.0183	0.0000	0.0000	0.0000
0703	206	1073		.4941	2.0130	0.0000	.0092
0703	206	1120		.0092	.1830	.0092	.0183
0703	206	1120		.2013	.4941	.0366	.0732
0703	206	1120		.2745	.0549	.0366	.0732
0703	206	1199		0.0000	0.0000	0.0000	.0366
0703	206	1199		0.0000	0.0000	.0183	0.0000
0703	206	1199		0.0000	.0366	0.0000	0.0000

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0703	206	1199		.0183	.0092	.0092	.0366
0703	206	1199		.0915	.4750	0.0000	0.0000
0703	206	1245		.0366	0.0000	0.0000	.0549
0703	207	1199		20.0000	200.0000	20.0000	0.0000
0703	208	1199		.0016	.0042	0.0000	0.0000

APPENDIX G

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0701	113		Other Seabirds	2.3000	2.3000	2.3000	2.3000
0702	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0702	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0702	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0702	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0702	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0702	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0702	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0702	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0702	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0702	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0702	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0702	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0702	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0702	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0702	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0702	111	515	Scaup	.6500	0.0000	.6500	.6500
0702	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0702	112	561	Blk. Crowned Knight Heron	1.0500	1.0500	1.0500	1.0500
0702	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0702	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0702	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0702	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0702	112	561	Louisiana Heron	2.0500	2.0500	2.0500	2.0500
0702	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0702	112	561	Snowy Egret	16.0500	16.0500	16.0500	16.0500
0702	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0702	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0702	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0702	113	546	Brown Pelican	.0100	.0100	.0100	.0100
0703	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
0703	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
0703	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
0703	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
0703	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
0703	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
0703	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
0703	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
0703	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
0703	111	515	Bufflehead	.1000	0.0000	.1000	.1000
0703	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
0703	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
0703	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
0703	111	515	Ringneck Duck	.0500	0.0000	.0500	.0500
0703	111	515	Ruddy Duck	.0500	0.0000	.0500	.0500
0703	111	515	Scaup	.6500	0.0000	.6500	.6500
0703	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
0703	112	561	Blk. Crowned Knight Heron	1.0500	1.0500	1.0500	1.0500
0703	112	561	Cattle Egret	.7600	.7600	.7600	.7600
0703	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
0703	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
0703	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
0703	112	561	Louisiana Heron	2.0500	2.0500	2.0500	2.0500
0703	112	561	Reddish Egret	.0200	.0200	.0200	.0200
0703	112	561	Snowy Egret	16.0500	16.0500	16.0500	16.0500

ZONE 7 - HOUSTON/GALVESTON, TX (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

Houston Port & Subzone	Species Category	(Port 7) Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0703	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
0703	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
0703	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
0703	113	546	Brown Pelican	.0100	.0100	.0100	.0100

APPENDIX H

CHESAPEAKE SOUTH/HAMPTON ROADS, VA

(ZONE 8)

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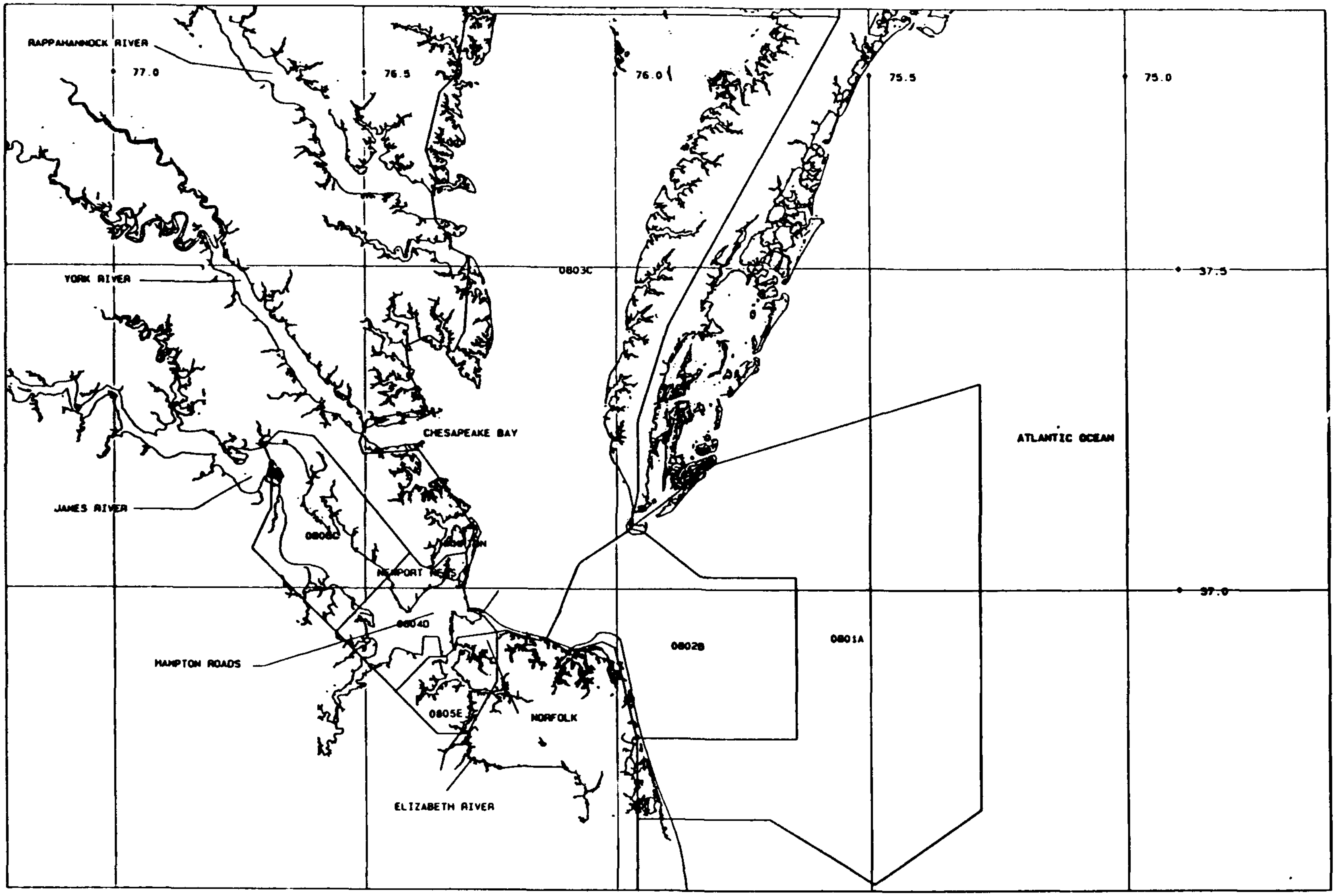
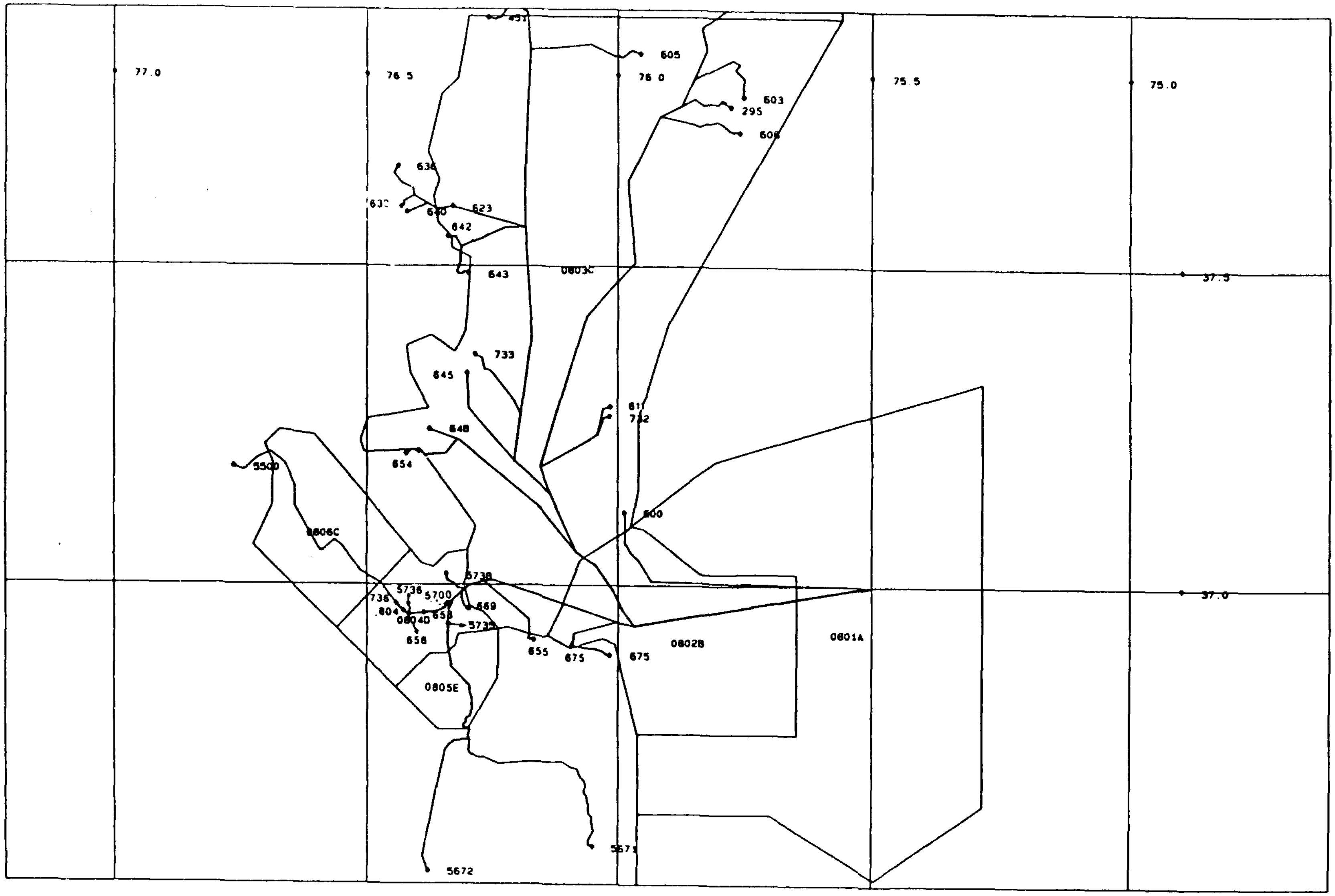
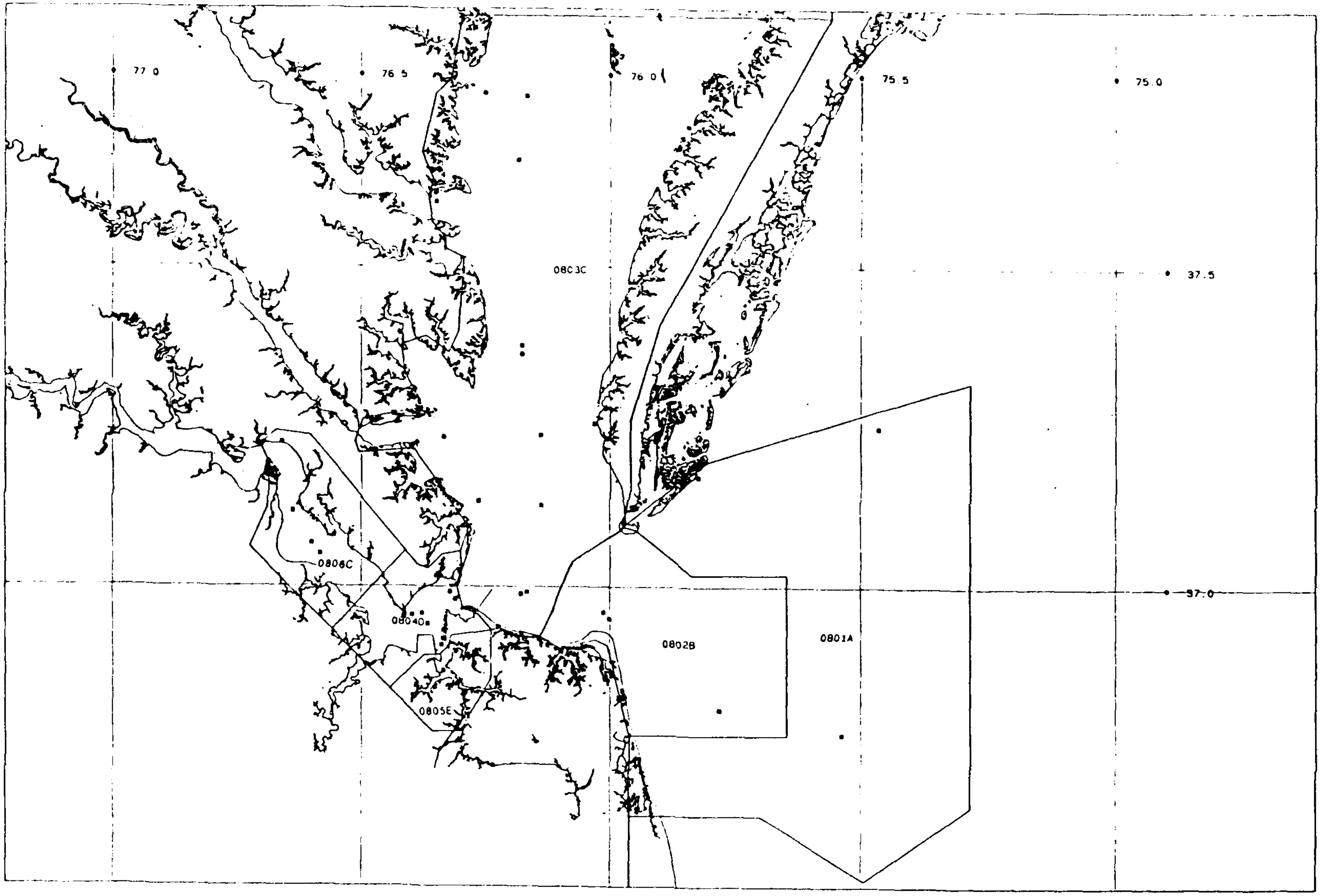
STUDY ZONE MAPS



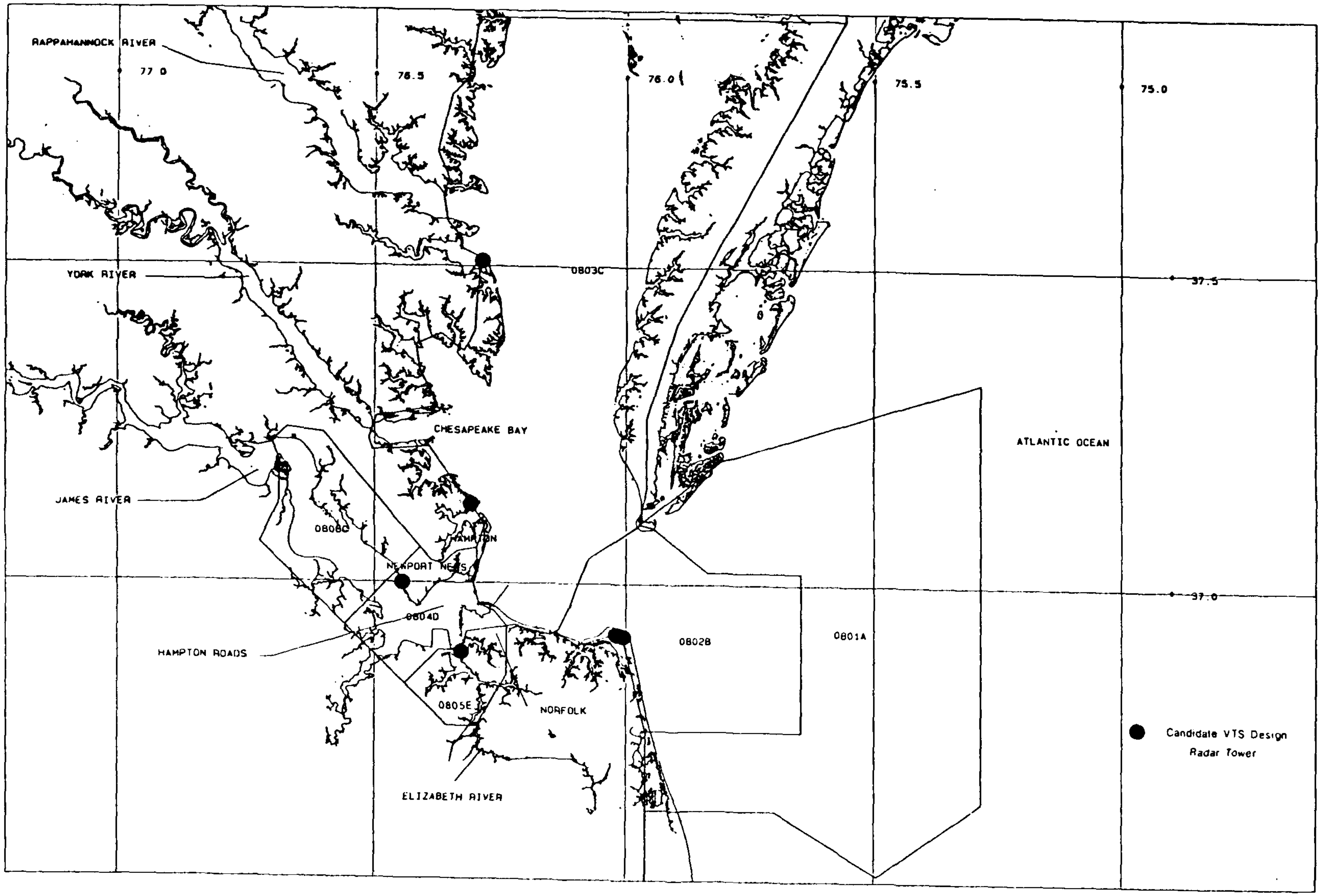
ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA - ZONE AND SUBZONE BOUNDARIES



ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

CHESAPEAKE SOUTH/HAMPTON ROADS, VA

(ZONE 8)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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APPENDIX

CHESAPEAKE BAY VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for the Chesapeake Bay. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 CHESAPEAKE BAY SURVEY

2.1 INTRODUCTION

Chesapeake Bay is the largest inland body of water on the Atlantic coast of the United States. Approximately 168 miles long and with a greatest width of 23 miles, the Bay is an important waterway giving access to Baltimore, Norfolk, Newport News and many lesser ports. It is also host to several major fisheries, is environmentally sensitive throughout its length, and is heavily used for recreational activities. Its southern portion is the site of the U. S. Navy's largest operating base on the East Coast.

The survey is limited to Chesapeake Bay itself, and excludes the Port of Baltimore north of the Chesapeake Bay Bridge and the entire Hampton Roads area lying west of the Chesapeake Bay Bridge-Tunnel. Traffic to and from these excluded areas was considered when traffic management needs for the Chesapeake Bay were evaluated, but, in general, each of the excluded areas is sufficiently active to warrant separate studies.

Groundings in the Chesapeake Bay are relatively hazard-free due to the mud, silt and sediment floor. Deep-draft traffic is confined to well-marked channels from which by regulation or commercial advantage lesser traffic is excluded. (The "commercial advantage" gained by shoal-draft traffic staying out of the deep-draft channels is shorter distances based upon more direct routing.) This natural separation coupled with the soft bottom, the characteristics of the traffic, and management exercised by the various Pilots Associations has given Chesapeake Bay an enviable traffic safety record.

2.2 OVERVIEW OF THE PORT

The entrance to Chesapeake Bay lies between Cape Charles, to the northward, and Cape Henry, to the southward. A deep channel lying close to Cape Henry is approached by deep-draft ships through buoyed lanes which extend southeastward from Cape Henry. A somewhat more shallow approach exists northeastward from Cape Henry and has controlling depths of 29' inbound and 34' outbound. The approaches to the east of Chesapeake Light are heavily used by the U. S. Navy for exercises, which occasionally can introduce a confusing random pattern for traffic movement.

The approaches are separated from Chesapeake Bay itself by the Chesapeake Bay Bridge-Tunnel (CBBT), which connects Cape Charles and Cape Henry. The two deep-draft openings through the CBBT are provided by the tunnel portions of the structure. The openings tend to sort Hampton Roads traffic from the traffic which serves other Chesapeake Bay areas. The area between the approaches and east of the CBBT is a major confluence area where four channels meet. It also serves as the Pilotage Area, where pilots are picked up and discharged, and contains a busy anchorage as well.

The South Ocean Approach Channel and the Thimble Shoal Channel have been improved to a limiting depth of 50', and a 55' Project has been authorized. Ships transiting to and from Baltimore are generally limited to 42' maximum draft, with future improvements expected to increase for outbound traffic to near 48'. Limiting drafts are a major issue between the Ports of Baltimore and Norfolk, as each struggles for competitive advantage. The importance of this issue is clear since one foot of draft equates to 3,600 tons of cargo.

In general terms, Chesapeake Bay shipping consists predominantly of bulk cargoes such as coal. There is some container and break-bulk traffic. Compared to Gulf ports, petro-chemical and hazardous material volumes are low. There is only one refinery, located along the York River, which receives crude by sea. A regionally significant volume of petroleum products, predominantly heating oil during the winter months, is moved by barge. Liquid Natural Gas (LNG) traffic to a terminal located just north of Cove Point is expected to commence operations during 1991. This will add an unspecified number of LNG ships to the overall traffic flow.

Northward from the CBBT, deep-draft shipping moves by a series of natural and dredged channels. The dredged channels, at York Spit and Rappahannock Spit, limit the draft of Baltimore traffic to 42'. The Rappahannock Spit Channel, known locally as the "Rappahannock Cross-over" can be difficult during winter months, because buoyage can be disturbed by ice. It also crosses the axis of the predominant tidal currents at nearly a 45° angle, requiring navigators to offset their headings by up to 10° to compensate for the effects of maximum ebb.

Tug and barge traffic tends to stay to the west of the deep-draft channels, seeking the most direct route up- and down-Bay. Deep-draft and other traffic converge at Smith Point and a Traffic Separation Scheme (TSS) has been established to regulate traffic flow there.

2.3 EXISTING TRAFFIC MANAGEMENT

The approaches to Chesapeake Bay through the Virginia Capes are marked by a series of Danger, Safety and Regulated Navigation Areas clearly described by the Coast Pilot (Reference 1). A series of special rules promulgated and enforced by the Captain of the Port (COTP), Hampton Roads apply within the Regulated Navigation Area. These Rules, among other things, impose restrictions upon anchoring, specify capabilities and require reporting of specific information (Reference 2).

The Traffic Separation Scheme (TSS), including the Precautionary Area, at Chesapeake Bay Entrance has been suspended pending realignment to accommodate a deeper draft channel. The proposed revisions, addressed by a "Notice of Proposed Rulemaking" soon to be published, will establish a South Ocean Approach TSS and expand safety-related requirements for ships drawing 45' or more and/or carrying hazardous material. A separate TSS remains in effect and regulates the flow of traffic in the vicinity of Smith Point Light (37°-52.8'N, 76°-11.0'W).

Much of upper Chesapeake Bay becomes a Regulated Navigation Area during periods of heavy icing when "conditions dictate", and when so designated by COTP Baltimore. At that time a series of special rules become effective. These apply to vessels over 100 Gross Tons and seek to reduce the likelihood of pollution and help insure the safety of navigation while movement is rendered difficult by ice (Reference 3).

There are a series of Danger Areas throughout the Chesapeake Bay, most incident to activities of the U. S. Armed Forces. These are clearly described by the Coast Pilot and by chart annotations.

It is notable that, because of the relatively featureless coastline coupled with low visibility 6-10% of the time, Loran-C is an important navigation aid when approaching the Virginia Capes. Its availability and accuracy dictated the selection of channel widths for the new proposed South Ocean Approach TSS and Deep Water Channel.

Reliable groundwave signals can be received night and day from pairs 9960-W, 9960-X, 9960-Z, and also from pairs 8970-W, 8970-X and 8970-Y. Loran-C readings of groundwave signals are based on a probable error of 0.1 microseconds and a maximum probable error of 0.3 microseconds. Assuming this magnitude of error, the line of position determined by readings for 9960-W, 9960-X, 9960-Y and 9960-Z have probable errors of 54, 38, 18 and 31 yards respectively. More detailed information may be obtained by referring to the Fleet Guide for Hampton Roads (Reference 4).

Pilotage is compulsory for all foreign vessels and for U. S. ships under register in the foreign trade. Pilotage is optional for U.S. Flag coastwise shipping if a pilot licensed by the Federal Government in these waters is on board. Principal pilot organizations are:

The Association of Maryland Pilots, providing pilotage to and from Maryland ports, including Baltimore, and the Capes.

The Association of Virginia Pilots, providing pilotage to and from Virginia ports, including those of Hampton Roads, and the Capes.

The Chesapeake and Interstate Pilots Association, a small group of Federally licensed pilots, provides pilotage to public and U.S. Flag coastwise vessels between the Capes and all ports within Chesapeake Bay.

The number of Federal pilots and the volume of traffic served are both small.

Deep-draft commercial traffic in Chesapeake Bay is managed by the Virginia and Maryland Pilots Associations, who cooperatively manage a lookout tower on USCG property at Cape Henry. This tower is manned by pilot apprentices, under pilot supervision, on a 24-hour basis. Communication is attempted with all commercial and naval traffic (call on Channel 16 and shift to Channel 14). Channel 16 (CH16) along with CH11, CH14, and CH74 are monitored in the tower. CH13 is monitored but the tower does not transmit on CH13. The tower facilitates rendezvous between pilots and arriving vessels but will respond to all calls from any mariner, and will attempt to provide assistance -- including the location of lost fishing and recreation vessels.

Two Racal-Decca radars (one X-band and one S-band) with two Racal-Decca Model 2690 BT, 26-in raster scan color displays with standard ARPA are installed in the tower. These radars are used to identify vessels, to assist the pilot boat in making contact, and to advise the pilots of other inbound and outbound traffic including fishing boats which operate in the deep water channels. This radar is not utilized for surveillance or tracking vessels inside Hampton Roads or after vessels have cleared the Chesapeake Channel above the Chesapeake Bay Bridge-Tunnel. When requested, assistance to pilots is provided in navigating through Thimble Shoal Channel and through

the Precautionary Area and the deep southbound channel, particularly during periods of reduced visibility and with deep draft colliers.

All pilot dispatching and collection of arrival and departure information is handled by separate pilot dispatch centers operated by each State Pilot Association and located near Lynnhaven Inlet. Radio communications facilities that essentially duplicate those in the tower are installed there. Information on ship arrivals and departures is sent over teleprinter line to the USCG (COTP Hampton Roads) and to the Hampton Roads Shipping Association, which performs a marine exchange function for the Hampton Roads ports.

As vessels proceed through Thimble Shoals Channel or on up Chesapeake Bay to other Virginia and Maryland ports, including Baltimore, the pilots maintain close radio contact with one another and with their Dispatch Center. There are communications dead-spots in the Chesapeake Bay which begin roughly at the Virginia-Maryland state line . The Maryland pilots use a radio relay station to overcome this problem. The pilots use CH13 extensively to managing traffic in Chesapeake Bay and use their house frequencies to communicate with their Dispatch Centers.

Each Virginia pilot has a FAX machine installed in his home establishing a "pilot's information network." This allows prompt relay of hard-copy notices that affect the waterways such as aids to navigation outages, LNG transits, special naval operations, etc. This information system forms an essential part of the pilots' traffic management system.

The Virginia pilots basically control which ship goes into the various anchorages available in the southern end of Chesapeake Bay (including those inside Hampton Roads). The COTP Hampton Roads, keeps track of the anchorages using the Pilot Dispatch Center reports.

The state pilots appear to maintain a close relationship with the Waterways Management Branch of the Fifth Coast Guard District. A large number of aids to navigation changes and Proposed Rule Making for the approaches to Chesapeake Bay have been coordinated closely and planned in consonance with the pilots. The schedules for the annual replacement of lighted aids with winter aids in the northern reaches of the Chesapeake is also coordinated with the pilots.

Both state pilot organizations feel they already have an effective Vessel Traffic Management System in place and see no reason for a Federal VTS to be installed. The COTP, Hampton Roads shares these views. However, there is general agreement concerning the need for additional anchorages and enforcement of existing rules by both participants and non-participants in the scheme.

Information on hazardous cargoes, particularly on container vessels, is generally not available to the pilots. The COTP Hampton Roads indicated that it is very people-intensive to inspect and inventory container vessels for hazardous cargoes and to keep pilots and others informed in a meaningful way.

In addition to the two state pilotage organizations, there are several other groups of pilots which are involved to a lesser extent in traffic movement (but not management). Federal Pilots operate on the Chesapeake and are cooperatively "tolerated" by the Virginia and Maryland pilots. U. S. Navy pilots assist USN ships in docking and undocking, and generally board/depart in the area immediately to the north of Fort Wool. Recently, most of the large auxiliaries, carriers and battleships take state pilots to assist in the Thimble Shoal Channel transit.

Management of USN traffic moving in the lower Chesapeake Bay and the Hampton Roads area is vested in the Navy's Senior Officer Present Afloat (Administrative) [SOPA ADMIN]. This responsibility is assigned to the Commander, Naval Base, Norfolk who exercises it through port control centers in Norfolk and Little Creek. These centers maintain visual and tactical radio communications with USN ships throughout the Hampton Roads area, exercising positive control over their movements as needed to manage traffic using USN facilities. This control is rarely coordinated with the state pilots and thus makes only marginal contributions to area-wide traffic management.

In general, CH13 communications throughout the Chesapeake are reported to be unencumbered and relatively clear of interference and misuse. The channel is not monitored by the Coast Guard.

One of the "natural" factors in traffic management in the Chesapeake is that deep draft vessels stay in deep channels and other traffic tends to use the rest of the waterway where there is sufficient water for safe transit. The critical areas are where traffic is exiting or entering an auxiliary channel or where waterways (such as Thimble Shoal Channel and York River Entrance Channel) converge with normally separated traffic. Tug and tow crossings through these confluence areas are of concern in traffic management.

2.4 VESSEL TRAFFIC

There are five major components to the traffic of Chesapeake Bay:

1. Deep-draft commercial shipping between the Capes and the ports of Hampton Roads. This shipping transits the study area between the CBBT and the sea. Although each ship is within the area for a relatively short period of time this component contributes approximately 4000 movements per year to the study area's traffic volume.

Hampton Roads commercial shipping is dominated by colliers, which represent the largest ships moving in Chesapeake Bay. Average dimensions approximate 1000' LOA, 135' BEAM and a loaded draft of 50'.

2. U. S. Navy movements between facilities of the Navy complex at the southern end of Chesapeake Bay, and between those facilities and the Capes. Most of the movements of interest are those between the CBBT and the sea, but individual and dual-ship exercises do occur within the Chesapeake Bay and there are other movements there as well. There is a USN Ammunition Depot on the York River, for example, and much of the Bay area immediately north of Wolftrap Light is designated as a Hurricane Anchorage for Norfolk-based USN ships. Ship types range from CVN to LCM and LACV's. Total annual movements are not available, but the study assumes 6000 movements per year, 2000 of which are between the CBBT and the sea.

3. Deep-draft commercial shipping between the Capes and the ports of Chesapeake Bay, excluding Hampton Roads. In tonnage, this traffic is dominated by bulk carriers but also includes containers and break-bulk. A small percentage is crude oil enroute to the refinery on the York River and there is some movement of petroleum products northward to Baltimore. In general, ships are smaller--at least in tonnage--than those calling at Hampton Roads ports.

4. Shoal-draft coastal and barge traffic plying throughout Chesapeake Bay. The volume is significant and, particularly during the winter months includes a large quantity of petroleum products, most notably heating fuel. An estimated 10,000 movements per year are used for study purposes. These movements lie to the west and north of the CBBT.

Movement of oil-carrying barges increase markedly during winter and can be hampered by the effects of ice upon buoys.

5. Recreational and fishing craft. The Hampton Roads area is homeport to a few offshore fishing boats which seem to disturb deep-draft shipping. During the interview sessions the study group heard allegations of incompetence and reckless disregard for navigation rules. The Virginia Pilots voiced concern about fishing craft using the deep-draft Thimble Shoal Channel, and about the possibility that efforts to avoid a fisherman could lead to a serious incident involving larger ships.

Most of the recreational boating concentrations are toward northern Chesapeake Bay, most noticeably along the western shore from Annapolis north. Pilots expressed some concern about traffic problems created from large numbers of small craft during the summer months.

Fishing within Chesapeake Bay occurs principally in shoal water areas well outside shipping lanes. In general, fishing areas are adequately marked by government-maintained buoys.

2.5 ENVIRONMENTAL SENSITIVITY

Chesapeake Bay contains tide- and wetlands of major importance to the maintenance of aquatic bird populations along the entire Eastern Seaboard. Its shoal water areas support major fisheries in shellfish, including crabs and oysters. Spills of petroleum products and/or hazardous chemicals would have a major effect upon these areas, and collision between a ship and a tank barge, or between a crude carrier and another ship, represent the "worse case" scenarios of COTPs Hampton Roads and Baltimore.

The National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency have a wealth of specific data about regional environmental and pollution concerns available. NOAA data may be obtained by contacting the Western Regional Office, Sand Point, Washington.

2.6 PORT SUB-ZONES

The harbor was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 5).

Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions

between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-regions within which VTS needs are homogeneous.

2.6.1 Sub-Zone I -- Offshore Approaches (NOAA Chart 12221)

The sub-zone consists of the approaches to the Virginia Capes lying seaward of a line drawn between the following points: 37°-06.7'N 75°-54.1'W, 37°-00.8'N 75°-50'W, 37°- 00.8'N 75°-39'W, 36°-46.3'N 75°-39'W; and thence due west to the Virginia coast.

This offshore approach area is the site of considerable traffic in addition to that bound to and from Chesapeake Bay. It includes the most common route taken by coastwise traffic and contains a number of busy USN exercise areas. Traffic within the sub-zone is classified as "open-complex".

2.6.2 Sub-Zone II -- Cape Henry Confluence (NOAA Chart 12221)

The sub-zone consists of that portion of Chesapeake Bay and its southern entrance lying inshore of Sub-Zone I and south of a line drawn across the Chesapeake Bay at 37°-20'N.

Excluded from the sub-zone is that portion of the Bay and Hampton Roads lying west of the Chesapeake Bay Bridge-Tunnel and south of a line drawn between Trestle B South End Light, and Northend Point Light. The York River west of 76°-27'W is also excluded.

It is estimated that some 10,000 movements per year occur within this sub-zone. In addition to moving traffic, the area is the site of the Pilotage Area, where pilots are picked up and discharged and includes a major anchorage.

The approach from seaward is made difficult, particularly in low visibility, by the low-lying and featureless coastline. This is offset by the excellent quality of Loran-C coverage. Westward passage through this sub-zone is through two openings in the CBBT. Seemingly quite wide, the abutments of the openings have been damaged by passing ships. Navigation within the sub-zone is clearly constrained by the presence of the CBBT.

These, combined with other limitations on navigation within the sub-zone imposed by regulation and/or channel depth, and the number of channel confluences require the sub-zone to be classified as "confined-complex".

2.6.3 Sub-Zone III -- Rappahannock Spit (NOAA Charts 12221 & 12225)

Sub-Zone III consists of that portion of Chesapeake Bay lying between 37°-20'N and 37°-46.5'N.

This sub-zone must be assigned a dual rating. For shoal draft traffic it is "open-simple", but deep-draft traffic constrained to the Rappahannock Spit Channel it must be considered as "confined-simple".

Shoal-draft traffic generally moves north-south along a route lying well to the west of that used by deep-draft shipping. The Rappahannock Spit Channel can present a navigational problem for deep-draft ships, particularly during low visibility or when buoys have been displaced by ice.

Installation of an all-weather range serving southbound traffic is planned, as is a "racon" range for northbound traffic.

2.6.4 Sub-Zone IV -- Northern Chesapeake Bay (NOAA Charts 12225, 12230 & 12263)

That portion of Chesapeake Bay lying between 37°-46.5'N and the William P. Lane, Jr. Memorial Bridge (Chesapeake Bay Bridge).

This sub-zone must be assigned a dual rating. For shoal draft traffic it is "open-simple", but deep-draft traffic constrained by draft it must be considered as "confined-simple."

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

2.7.1 PAI II-1. Southern Ocean Approach Channel

Inbound and outbound deep-draft ships are constrained to the limits of the marked channel by water depth. The intended changes to the South Ocean Approach Channel will also require ships carrying hazardous material to use the Deep Draft Channel.

2.7.2 PAI II-2. Confluence Area

That portion of Sub-Zone II where Thimble Shoals Channel, Chesapeake Channel, and the two approach channels converge. The PAI includes the Cape Henry Pilotage Area and the Chesapeake Bay Entrance Precautionary Area. Although the numbers of ship movements per year within the PAI have not been reliably tabulated it is estimated that there may be as many as 10,000, making this PAI one of the busiest waterway areas in the United States.

TABLE 2-1. CHESAPEAKE SOUTH/HAMPTON ROADS, VA PROBLEM AREA IDENTIFIER

PAI	LOCATION	PROBLEM	MANAGEMENT
II-1	Southern Ocean Approach Channel	Deep-draft ships and those carrying hazardous materials confined to Deep Water Channel. Navigation dependent upon buoyage and electronics (radar and Loran-C).	Knowledge of ship movements. Navigational assistance during periods of low visibility, non-availability of pilots and similar circumstance. Traffic advisory communications. Up-to-date weather, tidal and current information
II-2	Confluence Area	Major meeting point of inbound and outbound traffic, where five major channels converge and ships maneuver to pick up and discharge pilots.	Same As Above.
II-3	York Spit Channel	Convergence area with potential for random movements. Deep-draft ships may require nav. assistance during low visibility or when buoys are disturbed by ice.	Same As Above.
II-4	York River Entrance Channel	Convergence area with potential for random movements. Deep-draft ships may require nav. assistance during low visibility or when buoys are disturbed by ice.	Knowledge of ship movements. Navigational assistance during periods of low visibility, non-availability of pilots and similar circumstance. Traffic advisory communications. Up-to-date weather, tidal and current information
III-1	Rappahannock Spit Channel	Deep-draft ships constrained to channel may require nav. assistance during low visibility or when buoys are disturbed by ice.	Same as Above.

2.7.3 PAI II-3. York Spit Channel

That portion of the sub-zone which consists of the southern approaches to York Spit Channel and the channel itself. The southern approaches constitute a junction point for ships constrained by draft which will use the York Spit Channel, those who are sufficiently light to employ routing outside the Channel itself, and traffic bound to and from the York River Entrance Channel. The York River Entrance Channel is currently used by the region's only crude oil traffic.

2.7.4 PAI II-4. York River Entrance Channel

That portion of the sub-zone consisting of the southern entrance to the York River Entrance Channel and the channel itself to the western limits of the sub-zone. The southern approaches constitute a junction point for ships constrained by draft which will use the York Spit Channel, those who are sufficiently light to employ routing outside the Channel itself, and traffic bound to and from the York River Entrance Channel. The York River Entrance Channel is currently used by the region's only crude oil traffic.

2.7.5 PAI III-1. That portion of the sub-zone encompassed by Rappahannock Spit Channel

This PAI applies primarily to deep-draft traffic constrained to using the dredged channel. Because of the relationship of the Channel to the axis of the current vessels transiting at or near maximum current must "crab" as much as 10° to allow for set. Given the relatively featureless and low-lying shoreline navigation during poor visibility can be difficult, particularly during winter months when buoys may be displaced by ice.

3.0 CHESAPEAKE BAY VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Chesapeake Bay is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 1). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The four sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Chesapeake Bay VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port led to the overall conclusion that one control center managed by one watchstander and one supervisor is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone II

Cape Henry Site	1 Module 1 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET
	1 Module 15 HYD

Surveillance Modules-	Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
CHESAPEAKE BAY	I																			Required Comms Coverage from Facilities in Sub-Zone II
	II	1		1							3	1		1		1				
	III			1							1	1	1							
	IV										3	1	1							

FIGURE 3-1. CHESAPEAKE SOUTH/HAMPTON ROADS, VA VTS SURVEILLANCE SURVEY

Back River Site	1 Module 3 radar 1 Module 10 VHF
Savage Neck Site	1 Module 10 VHF

3.2.2.2 Sub-Zone III

Gwynn Island Site	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 12 MET

3.2.2.3 Sub-Zone IV

South Island Site	1 Module 10 VHF
Cedar Point Site	1 Module 10 VHF 1 Module 11 VHF 1 Module 12 MET
Tilghmans Island Site	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. Two watchstanders and a watch supervisor with integrated data workstations and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located at Cape Henry in a location with good visual surveillance. The center is to employ the following equipment:

3.2.3.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

o Software written in a high level language.

o Software providing the total integration of data from all VTS sensors.

o Layering of data in at least four layers to be operator selectable.

o The ability to sector data including sector to sector handoff of targets.

o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

o Complete modern color graphics capability with offset and zoom

o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides three operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Chesapeake Bay VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware Costs (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (2 workstations one supervisory console & all software)	1000	
Communications console	200	
Recording Equipment	100	
SCADA Equipment (3 radar sites)	100	
Sub-total:	1400	700

Sub-Zone I--Offshore Approaches (NOAA Chart 12221)

No hardware located in or required for this sub-zone

Sub-Zone II--Cape Henry Confluence (NOAA Chart 12221)

1 Module 1 radar	310	310
1 Module 3 radar	400	400
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
Sub-total:	905	779

Sub-Zone III--Rappahannock Spit (NOAA Charts 12221 & 12225)

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	487	438

Sub-Zone IV--Northern Chesapeake Bay (NOAA Charts 12225, 12230 & 12263)

3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	125	64
HARDWARE TOTALS:	2917	1981

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	**$2917**
Management, Engineering, etc. (50%) **Assumptions: Turnkey system, Procurement by integ.contractor,** good **manufacturer support, some** software **provided,System Manual required**	**1459**
Installation **site integration (10%)** **Assumptions: Complete installation** by contractor, **remote access no** serious problem, **three accessible sites**	**292**
Spares & Training **(10%)**	**292**
Civil **Engineering** 2 **remote** & 1 local **radar sites, a VTC in** Cape Henry several remote **comms and WX** sensors installations, minor **land** acquisition	**2000**
PROJECT ESTIMATE:	**6960**
Data Base Management System	**300**
TOTAL: (non-recurring)	**$7260**

Recurring (10 year)

Hardware	1981
2 Watchstanders x 5 = 10 man/years @ 50K x 10	5000
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$10481
TOTAL 10-YEAR PROJECT COST:	$17741

REFERENCES

1. United States Coast Pilot, Atlantic Coast: Sandy Hook to Cape Henry, 27th Edition, NOAA, Washington, D.C.

2. Ibid, pp. 51 and 52.

3. Ibid, pp. 53 and 54.

4. Fleet Guide, Hampton Roads, H.O. Publication 940, Chapter 5, 14th Edition, 1989, Defense Mapping Agency, Washington, D.C.

5. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-01.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: **Intracoastal Waterway**

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING SURVEILLANCE EQUIPMENT

CHESAPEAKE BAY/HAMPTON ROADS

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (3 workstations one supervisory console & all software)	1500	
Communications console	300	
Recording Equipment	150	
SCADA Equipment (3 radar sites)	600	
Sub-total:	2550	1000

CHESAPEAKE BAY

Sub-Zone I--Offshore Approaches (NOAA Chart 12221)

No hardware located in or required for this sub-zone

Sub-Zone II--Cape Henry Confluence (NOAA Chart 12221)

1 Module 1 radar	310	310
1 Module 3 radar	400	400
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
Sub-total:	905	779

Sub-Zone III--Rappahannock Spit (NOAA Charts 12221 & 12225)

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	487	438

Sub-Zone IV--Northern Chesapeake Bay (NOAA Charts 12225, 12230 & 12263)

3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	125	64
Chesapeake Bay Hardware Sub-totals:	1517	128
HARDWARE TOTALS:	1943	1299

Chesapeake Bay/Hampton Roads (Continued)

HAMPTON ROADS

Sub-Zone I -- Harbor Approach

This area is part of Chesapeake Sub-Zone II and is covered by Chesapeake surveillance. It acts as a hand-off sector for traffic entering the Hampton Roads/Norfolk Harbor. No new surveillance is required.

Sub-Zone II -- Bay Approaches

This area is part of Chesapeake Sub-Zone II and is covered by Chesapeake surveillance. It is a hand-off sector for traffic that enters Hampton Roads from the north. No new surveillance is required.

Sub-Zone III -- Little Creek Roads

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
Sub-total:	419	333

Sub-Zone IV -- Hampton Roads

Complete radar surveillance is provided from Sub-Zone III and Sub-Zone VI radars.

1 Module 10 VHF	19	13
Sub-total:	19	13

Sub-Zone V -- Newport News

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
Sub-total:	329	323

Sub-Zone VI

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 MET	40	5
Sub-total:	369	328
Hampton Roads Sub-total:	1136	997
Chesapeake/Hampton Roads Sub-total:	5203	3278

2.0 PROJECT TOTALS (x $1000)

2.1 Non-recurring

Hardware	5203
Management, Engineering, etc. (60%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	3122
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, three accessible sites	1041
Spares & Training (10%)	520
Civil Engineering 3 remote & 1 local radar sites, a VTC in Cape Henry several remote comms and WX sensors installations, minor land acquisition	3000
PROJECT ESTIMATE:	12886
Data Base Management System	300
TOTAL: (non-recurring)	13186

2.2 Recurring (10 year)

Hardware	3278
3 Watchstanders x 5 = 10 man/years @ 50K x 10	7500
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$14778
TOTAL 10-YEAR PROJECT COST:	$27964

Surveillance Modules-Sub Zones		RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
CHESAPEAKE BAY	I																			Required Comms Coverage from Facilities in Sub-Zone II
	II	1		1							3	1		1		1				
	III			1							1	1	1							
	IV										3	1	1							
	V																			
HAMP ROADS	I																			Part of Sub-zone 2 above
	II																			Part of Sub-zone 2 above
	III	1									1			1		1				Radar from Sub-zone 3 & 4
	IV										1									
	V	1									1									
	VI	1									1			1						

CHESAPEAKE BAY/HAMPTON ROADS SURVEILLANCE SUMMARY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 801A		
295	A	CHESCONESSEX CREEK, VA.
479	A	PATUXENT RIVER, MD.
600	A	DELAWARE BAY - CHESAPEAKE BAY WATERWAY - VIRGINIA PORTION
603	A	DEEP CREEK, ACCOMACK COUNTY, VA.
604	A	STARLINGS CREEK, VA.
605	A	TANGIER CHANNEL, VA.
606	A	ONANCOCK RIVER, VA.
608	A	OCCOHANNOCK CREEK, VA.
611	A	KINGS CREEK, NORTHAMPTON COUNTY, VA.
623	A	RAPPAHANNOCK RIVER, VA.
636	A	CARTERS CREEK, VA.
639	A	LOCKLIES CREEK, VA.
640	A	MILL CREEK, VA.
642	A	JACKSON CREEK, VA.
645	A	DAVIS CREEK, VA.
648	A	YORK RIVER, VA.
654	A	CHANNEL CONNECTING YORK RIVER, VA., WITH BACK CREEK TO
658	A	CHANNEL TO NEWPORT NEWS, VA.
700	A	BALTIMORE HARBOR AND CHANNELS, MD.
732	A	CAPE CHARLES CITY HARBOR, VA.
733	A	HORN HARBOR, VA.
736	A	PORT OF NEWPORT NEWS, VA.
736	B	PORT OF NEWPORT NEWS, VA.
5500	A	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5671	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5700	A	HAMPTON ROADS, VA.
5735	A	NORFOLK HARBOR, VA.
5735	B	NORFOLK HARBOR, VA.
5736	A	NEWPORT NEWS CREEK, VA.
Subzone 802B		
295	A	CHESCONESSEX CREEK, VA.
479	A	PATUXENT RIVER, MD.
600	A	DELAWARE BAY - CHESAPEAKE BAY WATERWAY - VIRGINIA PORTION
603	A	DEEP CREEK, ACCOMACK COUNTY, VA.
604	A	STARLINGS CREEK, VA.
605	A	TANGIER CHANNEL, VA.
606	A	ONANCOCK RIVER, VA.
608	A	OCCOHANNOCK CREEK, VA.
611	A	KINGS CREEK, NORTHAMPTON COUNTY, VA.
623	A	RAPPAHANNOCK RIVER, VA.
636	A	CARTERS CREEK, VA.
639	A	LOCKLIES CREEK, VA.
640	A	MILL CREEK, VA.
642	A	JACKSON CREEK, VA.
645	A	DAVIS CREEK, VA.
648	A	YORK RIVER, VA.
654	A	CHANNEL CONNECTING YORK RIVER, VA., WITH BACK CREEK TO
655	A	LITTLE RIVER (CREEK), VA.
658	A	CHANNEL TO NEWPORT NEWS, VA.
669	A	WILLOUGHBY CHANNEL, VA.
675	A	LYNHAVEN ROADS, INLET, AND CONNECTING WATERS, VA.

Appendix H   Zone 8   Chesapeake South/Hampton Roads, VA

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone	802B	
675	B	LYNHAVEN ROADS, INLET, AND CONNECTING WATERS, VA.
700	A	BALTIMORE HARBOR AND CHANNELS, MD.
732	A	CAPE CHARLES CITY HARBOR, VA.
733	A	HORN HARBOR, VA.
736	A	PORT OF NEWPORT NEWS, VA.
736	B	PORT OF NEWPORT NEWS, VA.
5500	A	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5671	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5700	A	HAMPTON ROADS, VA.
5735	A	NORFOLK HARBOR, VA.
5735	B	NORFOLK HARBOR, VA.
5736	A	NEWPORT NEWS CREEK, VA.
5738	A	HAMPTON CREEK, VA.
Subzone	803C	
295	A	CHESCONESSEX CREEK, VA.
295	B	CHESCONESSEX CREEK, VA.
451	A	LITTLE WICOMICO RIVER, VA.
479	A	PATUXENT RIVER, MD.
479	B	PATUXENT RIVER, MD.
600	A	DELAWARE BAY - CHESAPEAKE BAY WATERWAY - VIRGINIA PORTION
603	A	DEEP CREEK, ACCOMACK COUNTY, VA.
604	A	STARLINGS CREEK, VA.
604	B	STARLINGS CREEK, VA.
605	A	TANGIER CHANNEL, VA.
605	B	TANGIER CHANNEL, VA.
606	A	ONANCOCK RIVER, VA.
606	B	ONANCOCK RIVER, VA.
608	A	OCCOHANNOCK CREEK, VA.
608	B	OCCOHANNOCK CREEK, VA.
611	A	KINGS CREEK, NORTHAMPTON COUNTY, VA.
611	B	KINGS CREEK, NORTHAMPTON COUNTY, VA.
623	A	RAPPAHANNOCK RIVER, VA.
623	B	RAPPAHANNOCK RIVER, VA.
636	A	CARTERS CREEK, VA.
636	B	CARTERS CREEK, VA.
639	A	LOCKLIES CREEK, VA.
639	B	LOCKLIES CREEK, VA.
640	A	MILL CREEK, VA.
640	B	MILL CREEK, VA.
642	A	JACKSON CREEK, VA.
642	B	JACKSON CREEK, VA.
643	A	MILFORD HAVEN, VA.
645	A	DAVIS CREEK, VA.
645	B	DAVIS CREEK, VA.
648	A	YORK RIVER, VA.
648	B	YORK RIVER, VA.
654	A	CHANNEL CONNECTING YORK RIVER, VA., WITH BACK CREEK TO
654	B	CHANNEL CONNECTING YORK RIVER, VA., WITH BACK CREEK TO
655	A	LITTLE RIVER (CREEK), VA.
655	B	LITTLE RIVER (CREEK), VA.
658	A	CHANNEL TO NEWPORT NEWS, VA.
658	B	CHANNEL TO NEWPORT NEWS, VA.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 803C		
669	A	WILLOUGHBY CHANNEL, VA.
669	B	WILLOUGHBY CHANNEL, VA.
700	A	BALTIMORE HARBOR AND CHANNELS, MD.
700	B	BALTIMORE HARBOR AND CHANNELS, MD.
732	A	CAPE CHARLES CITY HARBOR, VA.
732	B	CAPE CHARLES CITY HARBOR, VA.
733	A	HORN HARBOR, VA.
733	B	HORN HARBOR, VA.
736	A	PORT OF NEWPORT NEWS, VA.
736	B	PORT OF NEWPORT NEWS, VA.
5500	A	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5500	B	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5671	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5671	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5700	A	HAMPTON ROADS, VA.
5700	B	HAMPTON ROADS, VA.
5735	A	NORFOLK HARBOR, VA.
5735	B	NORFOLK HARBOR, VA.
5736	A	NEWPORT NEWS CREEK, VA.
5736	B	NEWPORT NEWS CREEK, VA.
5738	A	HAMPTON CREEK, VA.
5738	B	HAMPTON CREEK, VA.
Subzone 804D		
658	A	CHANNEL TO NEWPORT NEWS, VA.
658	B	CHANNEL TO NEWPORT NEWS, VA.
669	A	WILLOUGHBY CHANNEL, VA.
669	B	WILLOUGHBY CHANNEL, VA.
736	A	PORT OF NEWPORT NEWS, VA.
736	B	PORT OF NEWPORT NEWS, VA.
5500	A	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5500	B	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5671	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5671	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5700	A	HAMPTON ROADS, VA.
5700	B	HAMPTON ROADS, VA.
5735	A	NORFOLK HARBOR, VA.
5735	B	NORFOLK HARBOR, VA.
5736	A	NEWPORT NEWS CREEK, VA.
5736	B	NEWPORT NEWS CREEK, VA.
5738	A	HAMPTON CREEK, VA.
5738	B	HAMPTON CREEK, VA.
Subzone 805E		
5671	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5671	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 805E		
5672	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5672	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
Subzone 806C		
5500	A	JAMES RIVER, VA. (CONSOLIDATED REPORT)
5500	B	JAMES RIVER, VA. (CONSOLIDATED REPORT)

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 801A Chesapeake Bay Approach

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	5,592,086	0	419,349	0	6.011,435
2	FOREST PRODUCTS	1,158,860	0	0	0	1,158,860
3	FISHERIES PRODUCTS	38,369	0	0	0	38,369
4	MINING PRODUCTS, NEC	129,641,548	0	28,734,135	0	158,375,683
5	PROC. FOODS & MFTRS, NEC	21,989,184	0	3,862,376	0	25,851,560
6	WASTE OF MANUFACTURING	651,597	0	96,487	0	748,084
1311	CRUDE PETROLEUM	0	3,951,985	0	130,117	4,082,102
1492	SULPHUR, DRY	4,242	0	158	0	4,400
2810	SODIUM HYDROXIDE (CAUSTI	28,233	0	30,854	0	59,087
2811	CRUDE PROD-COAL TAR-PET	89,745	0	1,839	0	91,584
2813	ALCOHOLS	0	134,300	0	8,144	142,444
2817	BENZENE AND TOLUENE	0	2,314	0	3,950	6,264
2818	SULPHURIC ACID	22,617	6,344	0	143,596	172,557
2871	NITROGEN CHEM FERTILIZER	15,734	2,041,628	0	1,238,409	3,295,771
2872	POTASSIC CHEM FERTILIZER	333,013	0	3,266	0	336,279
2873	PHOSPHA CHEM FERTILIZERS	11,508	0	56,519	0	68,027
2911	GASOLINE, INCL NATURAL	0	670,521	0	3,122,638	3,793,159
2912	JET FUEL	0	727,720	0	1,212,219	1,939,939
2913	KEROSENE	0	78,985	0	102,736	181,721
2914	DISTILLATE FUEL OIL	0	1,421,486	0	2,671,027	4,092,513
2915	RESIDUAL FUEL OIL	0	5,227,720	0	7,987,670	13,215,390
2916	LUBRIC OILS-GREASES	0	123,050	0	30,109	153,159
2917	NAPHTHA, PETRLM SOLVENTS	0	37,600	0	9,784	47,384
2921	LIQUI PETR-COAL-NATR GAS	262	115,848	0	6,157	122,267
	Subzone Total :	159,576,998	14,539,501	33,204,983	16,666,556	223,988,038

Subzone 802B Chesapeake Bay Entrance

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	5,592,086	0	419,349	0	6,011,435
2	FOREST PRODUCTS	1,158,860	0	0	0	1,158,860
3	FISHERIES PRODUCTS	38,369	0	0	0	38,369
4	MINING PRODUCTS, NEC	129,641,548	0	29,463,388	0	159,104,936
5	PROC. FOODS & MFTRS, NEC	21,989,184	0	3,862,376	0	25,851,560
6	WASTE OF MANUFACTURING	651,597	0	96,487	0	748,084
1311	CRUDE PETROLEUM	0	3,951,985	0	130,117	4,082,102
1492	SULPHUR, DRY	4,242	0	158	0	4,400
2810	SODIUM HYDROXIDE (CAUSTI	28,233	0	30,854	0	59,087
2811	CRUDE PROD-COAL TAR-PET	89,745	0	1,839	0	91,584
2813	ALCOHOLS	0	134,300	0	8,144	142,444
2817	BENZENE AND TOLUENE	0	2,314	0	3,950	6,264
2818	SULPHURIC ACID	22,617	6,344	0	143,596	172,557
2871	NITROGEN CHEM FERTILIZER	15,734	2,041,628	0	1,238,409	3,295,771
2872	POTASSIC CHEM FERTILIZER	333,013	0	3,266	0	336,279
2873	PHOSPHA CHEM FERTILIZERS	11,508	0	56,519	0	68,027
2911	GASOLINE, INCL NATURAL	0	670,521	0	3,122,638	3,793,159
2912	JET FUEL	0	727,720	0	1,213,357	1,941,077
2913	KEROSENE	0	78,985	0	103,938	182,923
2914	DISTILLATE FUEL OIL	0	1,421,486	0	2,737,670	4,159,156
2915	RESIDUAL FUEL OIL	0	5,227,720	0	7,987,670	13,215,390
2916	LUBRIC OILS-GREASES	0	123,050	0	30,109	153,159
2917	NAPHTHA, PETRLM SOLVENTS	0	37,600	0	9,784	47,384
2921	LIQUI PETR-COAL-NATR GAS	262	115,848	0	6,157	122,267
	Subzone Total :	159,576,998	14,539,501	33,934,236	16,735,539	224,786,274

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 803C Southern Chesapeake Bay

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	5,592,086	0	419,349	0	6,011,435
2	FOREST PRODUCTS	1,158,860	0	0	0	1,158,860
3	FISHERIES PRODUCTS	38,369	0	0	0	38,369
4	MINING PRODUCTS, NEC	129,641,548	0	29,463,388	0	159,104,936
5	PROC. FOODS & MFTRS, NEC	21,989,184	0	3,862,376	0	25,851,560
6	WASTE OF MANUFACTURING	651,597	0	96,487	0	748,084
1311	CRUDE PETROLEUM	0	3,951,985	0	130,117	4,082,102
1492	SULPHUR, DRY	4,242	0	158	0	4,400
2810	SODIUM HYDROXIDE (CAUSTI	28,233	0	30,854	0	59,087
2811	CRUDE PROD-COAL TAR-PET	89,745	0	1,839	0	91,584
2813	ALCOHOLS	0	134,300	0	8,144	142,444
2817	BENZENE AND TOLUENE	0	2,314	0	3,950	6,264
2818	SULPHURIC ACID	22,617	6,344	0	143,596	172,557
2871	NITROGEN CHEM FERTILIZER	15,734	2,041,628	0	1,238,409	3,295,771
2872	POTASSIC CHEM FERTILIZER	333,013	0	3,266	0	336,279
2873	PHOSPHA CHEM FERTILIZERS	11,508	0	56,519	0	68,027
2911	GASOLINE, INCL NATURAL	0	670,521	0	3,122,638	3,793,159
2912	JET FUEL	0	727,720	0	1,213,357	1,941,077
2913	KEROSENE	0	78,985	0	103,938	182,923
2914	DISTILLATE FUEL OIL	0	1,421,486	0	2,737,670	4,159,156
2915	RESIDUAL FUEL OIL	0	5,227,720	0	7,987,670	13,215,390
2916	LUBRIC OILS-GREASES	0	123,050	0	30,109	153,159
2917	NAPHTHA, PETRLM SOLVENTS	0	37,600	0	9,784	47,384
2921	LIQUI PETR-COAL-NATR GAS	262	115,848	0	6,157	122,267
	Subzone Total :	159,576,998	14,539,501	33,934,236	16,735,539	224,786,274

Subzone 804D James River Basin

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	3,842,147	0	287,778	0	4,129,925
2	FOREST PRODUCTS	1,070,843	0	0	0	1,070,843
3	FISHERIES PRODUCTS	28,789	0	0	0	28,789
4	MINING PRODUCTS, NEC	111,911,632	0	26,006,366	0	137,917,998
5	PROC. FOODS & MFTRS, NEC	13,949,551	0	2,927,901	0	16,877,452
6	WASTE OF MANUFACTURING	380,351	0	86,275	0	466,626
1311	CRUDE PETROLEUM	0	1,766,748	0	117,347	1,884,095
2810	SODIUM HYDROXIDE (CAUSTI	22,796	0	2,638	0	25,434
2811	CRUDE PROD-COAL TAR-PET	28,503	0	0	0	28,503
2813	ALCOHOLS	0	119,344	0	5,954	125,298
2817	BENZENE AND TOLUENE	0	34	0	4	38
2818	SULPHURIC ACID	7,070	6,344	0	81,466	94,880
2871	NITROGEN CHEM FERTILIZER	0	1,918,500	0	1,203,153	3,121,653
2872	POTASSIC CHEM FERTILIZER	246,108	0	3,224	0	249,332
2873	PHOSPHA CHEM FERTILIZERS	8,008	0	40,176	0	48,184
2911	GASOLINE, INCL NATURAL	0	224,339	0	2,166,674	2,391,013
2912	JET FUEL	0	719,372	0	940,848	1,660,220
2913	KEROSENE	0	24,794	0	61,305	86,099
2914	DISTILLATE FUEL OIL	0	286,050	0	1,965,549	2,251,599
2915	RESIDUAL FUEL OIL	0	4,021,934	0	5,326,081	9,348,015
2916	LUBRIC OILS-GREASES	0	86,182	0	14,574	100,756
2917	NAPHTHA, PETRLM SOLVENTS	0	234	0	24	258
2921	LIQUI PETR-COAL-NATR GAS	25	115,088	0	6,069	121,182
	Subzone Total :	131,495,823	9,288,963	29,354,358	11,889,048	182,028,192

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 805E Hampton Harbor

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	0	0	60,634	0	60,634
4	MINING PRODUCTS, NEC	0	0	745,938	0	745,938
5	PROC. FOODS & MFTRS, NEC	4,446	0	502,494	0	506,940
6	WASTE OF MANUFACTURING	0	0	26,635	0	26,635
2818	SULPHURIC ACID	0	0	0	19,890	19,890
2871	NITROGEN CHEM FERTILIZER	0	0	0	6,555	6,555
2873	PHOSPHA CHEM FERTILIZERS	0	0	13,392	0	13,392
2912	JET FUEL	0	0	0	204,587	204,587
2914	DISTILLATE FUEL OIL	0	0	0	13,778	13,778
2915	RESIDUAL FUEL OIL	0	0	0	31,680	31,680
	Subzone Total :	4,446	0	1,349,093	276,490	1,630,029

Subzone 806C Upper James River

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	75,360	0	0	0	75,360
2	FOREST PRODUCTS	4,774	0	0	0	4,774
4	MINING PRODUCTS, NEC	46,773	0	7,043,722	0	7,090,495
5	PROC. FOODS & MFTRS, NEC	518,832	0	335,997	0	854,829
6	WASTE OF MANUFACTURING	32,929	0	0	0	32,929
2811	CRUDE PROD-COAL TAR-PET	796	0	0	0	796
2813	ALCOHOLS	0	876	0	0	876
2818	SULPHURIC ACID	7,070	0	0	11,050	18,120
2871	NITROGEN CHEM FERTILIZER	0	267,640	0	194,093	461,733
2872	POTASSIC CHEM FERTILIZER	265	0	0	0	265
2873	PHOSPHA CHEM FERTILIZERS	2,002	0	0	0	2,002
2911	GASOLINE, INCL NATURAL	0	51,352	0	365,381	416,733
2912	JET FUEL	0	186,576	0	13,458	200,034
2913	KEROSENE	0	1,116	0	11,677	12,793
2914	DISTILLATE FUEL OIL	0	8,126	0	83,902	92,028
2915	RESIDUAL FUEL OIL	0	7,797	0	375,752	383,549
2916	LUBRIC OILS-GREASES	0	697	0	0	697
2921	LIQUI PETR-COAL-NATR GAS	25	0	0	0	25
	Subzone Total :	688,826	524,180	7,379,719	1,055,313	9,648,038

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 801A				
Passenger	0	20	0	20
Dry Cargo	804	3,848	0	4,652
Tanker	64	276	1,505	1,845
Dry Cargo Barge Tow	338	0	0	338
Tanker Barge Tow	129	0	0	129
Subzone Total:	1,335	4,144	1,505	6,984
Subzone : 802B				
Passenger	0	20	0	20
Dry Cargo	804	3,848	0	4,652
Tanker	64	276	1,505	1,845
Dry Cargo Barge Tow	338	0	0	338
Tanker Barge Tow	129	0	0	129
Subzone Total:	1,335	4,144	1,505	6,984
Subzone : 803C				
Passenger	0	20	0	20
Dry Cargo	804	3,848	12,272	16,924
Tanker	64	276	1,505	1,845
Dry Cargo Barge Tow	338	0	1,943	2,281
Tanker Barge Tow	129	0	4,959	5,088
Tug/Tow Boat	0	0	13,912	13,912
Subzone Total:	1,335	4,144	34,591	40,070
Subzone : 804D				
Passenger	0	18	1,178	1,196
Dry Cargo	3,258	7,287	34,694	45,239
Tanker	239	546	6,044	6,829
Dry Cargo Barge Tow	257	0	29,547	29,804
Tanker Barge Tow	119	0	3,771	3,890
Tug/Tow Boat	0	0	27,979	27,979
Subzone Total:	3,872	7,851	103,213	114,936

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 805E				
Passenger	0	0	28,012	28,012
Dry Cargo	0	0	14	14
Dry Cargo Barge Tow	0	0	1,693	1,693
Tanker Barge Tow	0	0	99	99
Tug/Tow Boat	0	0	826	826
Subzone Total:	0	0	30,643	30,643
Subzone : 806C				
Dry Cargo	0	226	24,930	25,156
Tanker	0	12	43	55
Dry Cargo Barge Tow	5	0	10,812	10,817
Tanker Barge Tow	11	0	290	301
Tug/Tow Boat	0	0	1,277	1,277
Subzone Total:	16	238	37,351	37,605

Note: Sum of all vessel transits within each study subzone.

ZONE TOTALS

ZONE 8 Chesapeake South/Hampton Roads, VA

Vessel Type	Large	Medium	Small	Total
Passenger	0	38	28,012	28,050
Dry Cargo	4,064	11,149	103,808	119,021
Tanker	365	884	7,632	8,881
Dry Cargo Barge Tow	595	0	34,758	35,353
Tanker Barge Tow	346	0	9,444	9,790
Tug/Tow Boat	0	0	43,571	43,571
Zone Total:	5,369	12,071	227,225	244,665

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 801A Chesapeake Bay Approach		
658	CHANNEL TO NEWPORT NEWS, VA.	2	2
736	PORT OF NEWPORT NEWS, VA.(INCLUDING NEWPORT NEWS CREEK, VA.)	2	2
5500	JAMES RIVER, VA. (CONSOLIDATED REPORT)	2	2
5671	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) VIA GREAT BRIDGE LOCK ROUTE	2	2
5672	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) DISMAL SWAMP AND	2	2
5700	HAMPTON ROADS, VA.	2	2
5735	NORFOLK HARBOR, VA.	2	2
	SUBZONE 802B Chesapeake Bay Entrance		
658	CHANNEL TO NEWPORT NEWS, VA.	2	2
736	PORT OF NEWPORT NEWS, VA.(INCLUDING NEWPORT NEWS CREEK, VA.)	2	2
5500	JAMES RIVER, VA. (CONSOLIDATED REPORT)	2	2
5671	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) VIA GREAT BRIDGE LOCK ROUTE	2	2
5672	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) DISMAL SWAMP AND	2	2
5700	HAMPTON ROADS, VA.	2	2
5735	NORFOLK HARBOR, VA.	2	2
5738	HAMPTON CREEK, VA.	2	2
	SUBZONE 803C Southern Chesapeake Bay		
658	CHANNEL TO NEWPORT NEWS, VA.	2	2
736	PORT OF NEWPORT NEWS, VA.(INCLUDING NEWPORT NEWS CREEK, VA.)	2	2
5500	JAMES RIVER, VA. (CONSOLIDATED REPORT)	2	2
5671	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) VIA GREAT BRIDGE LOCK ROUTE	2	2
5672	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) DISMAL SWAMP AND	2	2
5700	HAMPTON ROADS, VA.	2	2
5735	NORFOLK HARBOR, VA.	2	2
5738	HAMPTON CREEK, VA.	2	2
	SUBZONE 804D James River Basin		
658	CHANNEL TO NEWPORT NEWS, VA.	2	2
736	PORT OF NEWPORT NEWS, VA.(INCLUDING NEWPORT NEWS CREEK, VA.)	2	2
5500	JAMES RIVER, VA. (CONSOLIDATED REPORT)	2	2
5671	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) VIA GREAT BRIDGE LOCK ROUTE	2	2
5672	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) DISMAL SWAMP AND	2	2
5700	HAMPTON ROADS, VA.	2	2
5735	NORFOLK HARBOR, VA.	2	2
5738	HAMPTON CREEK, VA.	2	2
	SUBZONE 805E Hampton Harbor		
5671	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) VIA GREAT BRIDGE LOCK ROUTE	2	2
5672	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA. (NORFOLK DISTRICT) DISMAL SWAMP AND	2	2
	SUBZONE 806C Upper James River		
5500	JAMES RIVER, VA. (CONSOLIDATED REPORT)	2	2

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
801A	Chesapeake Bay Approach	5,693	4.51
802B	Chesapeake Bay Entrance	12,960	31.84
803C	Southern Chesapeake Bay	6,098	4.43
804D	James River Basin	4,184	64.37
805E	Hampton Harbor	6,345	423.00
806C	Upper James River	2,628	32.85
	Total for Zone	37,908	11.81

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 801A				
Passenger	0	39	0	39
Dry Cargo	4,976	13,891	96,667	115,534
Tanker	427	1,016	8,509	9,952
Dry Cargo Tow	215	0	38,433	38,648
Tanker Tow	257	0	10,363	10,619
Tug/Tow Boat	0	0	52,044	52,044
Subzone Total:	5,875	14,946	206,015	226,836
Subzone : 802B				
Passenger	0	39	0	39
Dry Cargo	4,976	13,891	99,422	118,289
Tanker	427	1,016	8,782	10,225
Dry Cargo Tow	215	0	40,948	41,163
Tanker Tow	257	0	10,451	10,708
Tug/Tow Boat	0	0	51,250	51,250
Subzone Total:	5,875	14,946	210,853	231,674
Subzone : 803C				
Passenger	0	39	0	39
Dry Cargo	4,976	13,891	122,256	141,123
Tanker	427	1,016	8,782	10,225
Dry Cargo Tow	215	0	40,948	41,163
Tanker Tow	257	0	10,444	10,701
Tug/Tow Boat	0	0	51,220	51,220
Subzone Total:	5,875	14,946	233,650	254,471
Subzone : 804D				
Passenger	0	19	1,218	1,237
Dry Cargo	3,968	8,999	43,795	56,762
Tanker	275	640	7,056	7,971
Dry Cargo Tow	0	0	34,929	34,929
Tanker Tow	116	0	4,222	4,338
Tug/Tow Boat	0	0	33,678	33,678
Subzone Total:	4,359	9,658	124,898	138,914

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 805E				
Passenger	0	0	28,963	28,963
Dry Cargo	0	0	17	17
Dry Cargo Tow	0	0	2,325	2,325
Tanker Tow	0	0	111	111
Tug/Tow Boat	0	0	354	354
Subzone Total:	0	0	31,769	31,769
Subzone : 806C				
Dry Cargo	0	307	31,749	32,056
Tanker	0	14	56	70
Dry Cargo Tow	0	0	12,663	12,663
Tanker Tow	0	0	325	325
Tug/Tow Boat	0	0	1,724	1,724
Subzone Total:	0	321	46,516	46,837

Note: Sum of all vessel transits within each study subzone.

Appendix H **ZONE** 8 Chesapeake South/Hampton Roads, VA 7/24/91

TABLE 6.2 **Forecast 2000**
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 801A				
Passenger	0	41	0	41
Dry Cargo	5,704	15,915	108,641	130,260
Tanker	480	1,120	9,411	11,011
Dry Cargo Tow	245	0	42,397	42,642
Tanker Tow	279	0	11,125	11,404
Tug/Tow Boat	0	0	60,139	60,139
Subzone Total:	6,708	17,076	231,712	255,495
Subzone : 802B				
Passenger	0	41	0	41
Dry Cargo	5,704	15,915	111,528	133,147
Tanker	480	1,120	9,697	11,297
Dry Cargo Tow	245	0	45,104	45,349
Tanker Tow	279	0	11,220	11,498
Tug/Tow Boat	0	0	59,283	59,283
Subzone Total:	6,708	17,076	236,831	260,614
Subzone : 803C				
Passenger	0	41	0	41
Dry Cargo	5,704	15,915	135,462	157,081
Tanker	480	1,120	9,697	11,297
Dry Cargo Tow	245	0	45,104	45,349
Tanker Tow	279	0	11,213	11,491
Tug/Tow Boat	0	0	59,252	59,252
Subzone Total:	6,708	17,076	260,727	284,510
Subzone : 804D				
Passenger	0	19	1,259	1,279
Dry Cargo	4,534	10,234	50,933	65,701
Tanker	307	715	7,856	8,878
Dry Cargo Tow	0	0	38,527	38,527
Tanker Tow	129	0	4,533	4,661
Tug/Tow Boat	0	0	38,615	38,615
Subzone Total:	4,970	10,968	141,722	157,660

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 805E				
Passenger	0	0	29,946	29,946
Dry Cargo	0	0	19	19
Dry Cargo Tow	0	0	2,557	2,557
Tanker Tow	0	0	120	120
Tug/Tow Boat	0	0	390	390
Subzone Total:	0	0	33,031	33,031
Subzone : 806C				
Dry Cargo	0	378	37,296	37,674
Tanker	0	16	67	83
Dry Cargo Tow	0	0	13,978	13,978
Tanker Tow	0	0	348	348
Tug/Tow Boat	0	0	2,118	2,118
Subzone Total:	0	394	53,806	54,200

Note: Sum of all vessel transits within each study subzone.

Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 801A				
Passenger	0	42	0	42
Dry Cargo	6,560	18,382	122,879	147,821
Tanker	543	1,244	10,464	12,251
Dry Cargo Tow	280	0	46,776	47,056
Tanker Tow	306	0	11,946	12,251
Tug/Tow Boat	0	0	70,052	70,052
Subzone Total:	7,689	19,668	262,116	289,472
Subzone : 802B				
Passenger	0	42	0	42
Dry Cargo	6,560	18,382	125,888	150,830
Tanker	543	1,244	10,763	12,550
Dry Cargo Tow	280	0	49,684	49,964
Tanker Tow	306	0	12,047	12,352
Tug/Tow Boat	0	0	69,133	69,133
Subzone Total:	7,689	19,668	267,514	294,870
Subzone : 803C				
Passenger	0	42	0	42
Dry Cargo	6,560	18,382	150,828	175,770
Tanker	543	1,244	10,763	12,550
Dry Cargo Tow	280	0	49,684	49,964
Tanker Tow	306	0	12,040	12,345
Tug/Tow Boat	0	0	69,100	69,100
Subzone Total:	7,689	19,668	292,414	319,770
Subzone : 804D				
Passenger	0	20	1,296	1,316
Dry Cargo	5,199	11,744	59,758	76,701
Tanker	343	808	8,802	9,953
Dry Cargo Tow	0	0	42,496	42,496
Tanker Tow	145	0	4,868	5,012
Tug/Tow Boat	0	0	44,693	44,693
Subzone Total:	5,687	12,572	161,912	180,171

Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 805E				
Passenger	0	0	30,825	30,825
Dry Cargo	0	0	21	21
Dry Cargo Tow	0	0	2,813	2,813
Tanker Tow	0	0	129	129
Tug/Tow Boat	0	0	430	430
Subzone Total:	0	0	34,217	34,217
Subzone : 806C				
Dry Cargo	0	473	44,181	44,654
Tanker	0	19	81	100
Dry Cargo Tow	0	0	15,429	15,429
Tanker Tow	0	0	373	373
Tug/Tow Boat	0	0	2,640	2,640
Subzone Total:	0	492	62,703	63,195

Note: Sum of all vessel transits within each study subzone.

Appendix H **ZONE 8 Chesapeake** South/Hampton **Roads,** VA

TABLE 6.4 *Forecast 2010*
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 801A				
Passenger	0	43	0	43
Dry Cargo	7,586	21,353	139,966	168,905
Tanker	619	1,387	11,714	13,720
Dry Cargo Tow	321	0	51,612	51,933
Tanker Tow	335	0	12,826	13,160
Tug/Tow Boat	0	0	82,152	82,152
Subzone Total:	3,861	22,783	298,269	329,913
Subzone : 802B				
Passenger	0	43	0	43
Dry Cargo	7,586	21,353	143,082	172,021
Tanker	619	1,387	12,023	14,029
Dry Cargo Tow	321	0	54,730	55,051
Tanker Tow	335	0	12,935	13,270
Tug/Tow Boat	0	0	81,166	81,166
Subzone Total:	8,861	22,783	303,936	335,580
Subzone : 803C				
Passenger	0	43	0	43
Dry Cargo	7,586	21,353	168,915	197,854
Tanker	619	1,387	12,023	14,029
Dry Cargo Tow	321	0	54,730	55,051
Tanker Tow	335	0	12,927	13,262
Tug/Tow Boat	0	0	81,132	81,132
Subzone Total:	8,861	22,783	329,727	361,371
Subzone : 804D				
Passenger	0	20	1,334	1,355
Dry Cargo	5,996	13,560	70,709	90,265
Tanker	388	918	9,930	11,236
Dry Cargo Tow	0	0	46,877	46,877
Tanker Tow	163	0	5,229	5,392
Tug/Tow Boat	0	0	52,129	52,129
Subzone Total:	6,547	14,498	186,208	207,253

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Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 805E				
Passenger	0	0	31,729	31,729
Dry Cargo	0	0	24	24
Dry Cargo Tow	0	0	3,096	3,096
Tanker Tow	0	0	139	139
Tug/Tow Boat	0	0	474	474
Subzone Total:	0	0	35,461	35,461
Subzone : 806C				
Dry Cargo	0	600	52,809	53,409
Tanker	0	22	99	121
Dry Cargo Tow	0	0	17,031	17,031
Tanker Tow	0	0	400	400
Tug/Tow Boat	0	0	3,336	3,336
Subzone Total:	0	622	73,674	74,296

Note: Sum of all vessel transits within each study subzone.

Appendix H ZONE 8 Chesapeake South/Hampton Roads, VA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	39	28,963	29,002
Dry Cargo	4,489	12,575	117,692	134,756
Tanker	435	1,016	8,790	10,241
Dry Cargo Tow	215	0	40,594	40,809
Tanker Tow	257	0	10,571	10,828
Tug/Tow Boat	0	0	51,446	51,446
1995 Zone Total:	5,396	13,630	258,056	277,082
2000 FORECASTED ZONE TOTALS				
Passenger	0	41	29,946	29,987
Dry Cargo	4,824	13,548	126,691	145,063
Tanker	503	1,120	9,720	11,343
Dry Cargo Tow	245	0	44,714	44,959
Tanker Tow	279	0	11,347	11,625
Tug/Tow Boat	0	0	59,488	59,488
2000 Zone Total:	5,851	14,709	281,905	302,465
2005 FORECASTED ZONE TOTALS				
Passenger	0	42	30,825	30,867
Dry Cargo	5,549	15,153	138,412	159,114
Tanker	582	1,244	10,802	12,628
Dry Cargo Tow	280	0	49,255	49,535
Tanker Tow	306	0	12,181	12,486
Tug/Tow Boat	0	0	69,348	69,348
2005 Zone Total:	6,717	16,439	310,821	333,977
2010 FORECASTED ZONE TOTALS				
Passenger	0	43	31,729	31,772
Dry Cargo	6,417	17,607	154,075	178,099
Tanker	674	1,387	12,078	14,139
Dry Cargo Tow	321	0	54,257	54,578
Tanker Tow	335	0	13,076	13,411
Tug/Tow Boat	0	0	81,390	81,390
2010 Zone Total:	7,747	19,037	346,605	373,388

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 801A Chesapeake Bay Approach						
Fishing	Small	2	0	2	0	4
Subzone Totals:		2	0	2	0	4
Subzone: 802B Chesapeake Bay Entrance						
Dry Cargo	Large	1	0	1	0	2
Dry Cargo	Medium	0	1	0	0	1
Tanker	Medium	1	0	0	0	1
Tug/Tow Boat	Small	1	0	0	0	1
Subzone Totals:		3	1	1	0	5
Subzone: 803C Southern Chesapeake Bay						
Dry Cargo	Large	0	0	2	0	2
Dry Cargo Barge Tow	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	1	3	1	6
Tanker Barge Tow	Small	0	1	1	0	2
Tug/Tow Boat	Small	0	0	2	0	2
Fishing	Small	2	0	0	0	2
Other	Small	1	2	1	0	4
Subzone Totals:		4	4	10	1	19
Subzone: 804D James River Basin						
Passenger	Small	1	0	0	0	1
Dry Cargo	Large	1	1	3	0	5
Dry Cargo	Small	1	0	0	0	1
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	0	1	0	2
Tanker Barge Tow	Small	0	1	3	0	4
Fishing	Small	0	0	2	0	2
Other	Small	0	2	0	0	2
Subzone Totals:		4	4	10	0	18

Note: OTHER equals barge breakaways and weather caused vessel casualties.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 805E Hampton Harbor						
Passenger	Small	1	0	0	0	1
Tanker	Large	2	0	0	0	2
Dry Cargo Barge Tow	Small	2	1	0	0	3
Tanker Barge Tow	Small	2	0	0	0	2
Tug/Tow Boat	Small	1	0	0	0	1
Fishing	Small	0	0	1	0	1
Other	Small	1	0	0	0	1
Subzone Totals:		9	1	1	0	11
Subzone: 806C Upper James River						
Dry Cargo Barge Tow	Small	0	1	0	0	1
Tanker Barge Tow	Small	0	0	3	0	3
Subzone Totals:		0	1	3	0	4
Zone Totals:		22	11	27	1	61

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE H-8 ZONE 8, CHESAPEAKE SOUTH/HAMPTON ROADS - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0801A	II	II	II	II	II	II	II	II	II	II	II	II					III
0802B	II	II	II	II	II	II	II	II	II	II	II	II					III
0803C	II	II	II	II	II	II	II	II	II	II	II	II					III
0804D																	III
0805E																	III
0806C																	III

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

NOTE ALL VESSELS WITH DRAFT GREATER THAN 18 FEET, AND 60% OF BARGES PARTICIPATE 1979 THROUGH PRESENT.

APPENDIX TABLE H-9 ZONE 8, CHESAPEAKE SOUTH/HAMPTON ROADS, VA
CANDIDATE VTS DESIGN - 1995-2010

UNITS		
4	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
2	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
11	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
2	Meteorological Module 12	- Air temperature, wind direction and speed
3	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
2	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.02	.04
Passenger	Small	.58	.08	.46	1.12
Dry Cargo	Large	.70	.12	.92	1.74
Dry Cargo	Medium	.89	.15	.42	1.46
Dry Cargo	Small	1.42	.17	.29	1.88
Tanker	Large	.12	.03	.18	.33
Tanker	Medium	.04	.00	.03	.07
Tanker	Small	.15	0.00	.12	.26
Dry Cargo Barge T	Large	.29	0.00	.36	.65
Dry Cargo Barge T	Small	4.91	1.49	1.93	8.33
Tanker Barge Tow	Large	.03	.01	.02	.07
Tanker Barge Tow	Small	.84	.15	.65	1.65
Tug/Tow Boat	Small	.64	.22	.48	1.34
		10.62	2.44	5.89	18.94

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	27	0	23	50
Passenger	Small	506	73	289	868
Dry Cargo	Large	1,008	214	296	1,518
Dry Cargo	Medium	1,389	296	132	1,817
Dry Cargo	Small	977	107	175	1,260
Tanker	Large	462	115	336	913
Tanker	Medium	65	7	15	86
Tanker	Small	80	0	26	106
Dry Cargo Barge T	Large	33	0	7	41
Dry Cargo Barge T	Small	264	79	31	375
Tanker Barge Tow	Large	365	189	193	747
Tanker Barge Tow	Small	2,196	412	201	2,808
Tug/Tow Boat	Small	48	21	34	103
		7,421	1,512	1,759	10,692

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA

TABLE 10B — A.'oided Vessel Casualties 1996 - 2010 — 7/31/91

Existing VTS Systems

Count~

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.02	.04
Dry Cargo	Large	.30	.07	.61	.98
Dry Cargo	Medium	.57	.13	.37	1.08
Dry Cargo	Small	.23	.04	.07	.34
Tanker	Large	.06	.02	.13	.21
Tanker	Medium	.02	.00	.02	.05
Tanker	Small	.05	0.00	.07	.12
Dry Cargo Barge T	Large	.35	0.00	.49	.84
Dry Cargo Barge T	Small	.19	.08	.13	.40
Tanker Barge Tow	Large	.02	.02	.03	.07
Tanker Barge Tow	Small	.47	.12	.54	1.13
Tug/Tow Boat	Small	.21	.10	.26	.58
		2.50	.58	2.75	5.83

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	23	0	25	48
Dry Cargo	Large	432	137	195	764
Dry Cargo	Medium	899	265	119	1,282
Dry Cargo	Small	159	28	43	230
Tanker	Large	274	93	280	647
Tanker	Medium	36	6	12	54
Tanker	Small	23	0	15	38
Dry Cargo Barge T	Large	41	0	10	51
Dry Cargo Barge T	Small	11	13	2	26
Tanker Barge Tow	Large	308	204	210	722
Tanker Barge Tow	Small	1,267	333	171	1,771
Tug/Tow Boat	Small	16	18	19	53
		3,489	1,096	1,102	5,687

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.04	.01	.03	.07
Dry Cargo	Large	.09	.01	.12	.22
Dry Cargo	Medium	.11	.02	.05	.18
Dry Cargo	Small	.09	.01	.02	.12
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.02
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.34	.05	.23	.62
Candidate VTS Design - Dollars					
Passenger	Medium	2,814.53	0.00	3,947.25	6,761.79
Passenger	Small	55,465.24	7,909.84	44,645.47	108,020.55
Dry Cargo	Large	131,991.74	22,486.20	173,484.85	327,962.79
Dry Cargo	Medium	167,792.54	28,536.65	79,166.84	275,496.03
Dry Cargo	Small	136,677.68	16,337.24	27,404.92	180,419.84
Tanker	Small	479.69	0.00	385.63	865.33
Dry Cargo Barge Tow	Small	16,235.03	4,930.25	6,389.86	27,555.14
Tanker Barge Tow	Small	2,776.50	511.24	2,160.83	5,448.57
Tug/Tow Boat	Small	2,106.23	726.44	1,588.54	4,421.22
Totals		516,339.19	81,437.86	339,174.19	936,951.25
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Dry Cargo	Large	.04	.01	.08	.12
Dry Cargo	Medium	.07	.02	.05	.14
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.13	.03	.13	.29
Existing VTS Design - Dollars					
Passenger	Medium	2,393.49	0.00	4,285.74	6,679.23
Dry Cargo	Large	56,550.57	13,429.08	114,567.52	184,547.17
Dry Cargo	Medium	108,154.78	24,327.91	70,415.66	202,898.34
Dry Cargo	Small	22,230.39	3,662.66	6,677.89	32,570.94
Tanker	Small	172.15	0.00	232.13	404.28
Dry Cargo Barge Tow	Small	624.91	274.13	430.33	1,329.37
Tanker Barge Tow	Small	1,548.57	392.05	1,791.52	3,732.14
Tug/Tow Boat	Small	692.29	340.42	873.24	1,905.94
Totals		192,367.16	42,426.24	199,274.01	434,067.41

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.44	.06	.35	.85
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.01	.00	.01	.02
Dry Cargo	Small	1.08	.13	.22	1.43
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	.12	.04	.05	.20
Tanker Barge Tow	Small	.02	.00	.02	.04
Tug/Tow Boat	Small	.02	.01	.01	.03
Totals		1.70	.24	.67	2.60
Candidate VTS Design - Dollars					
Passenger	Medium	48.32	0.00	67.77	116.10
Passenger	Small	104,441.96	14,894.36	84,068.17	203,404.49
Dry Cargo	Large	2,266.26	386.08	2,978.69	5,631.04
Dry Cargo	Medium	2,880.95	489.97	1,359.27	4,730.20
Dry Cargo	Small	257,366.34	30,763.30	51,603.91	339,733.56
Tanker	Small	838.18	0.00	673.82	1,512.00
D.y Cargo Barge Tow	Small	28,367.69	8,614.70	11,165.09	48,147.48
Tanker Barge Tow	Small	4,851.43	893.29	3,775.65	9,520.37
Tug/Tow Boat	Small	3,680.24	1,269.32	2,775.69	7,725.25
Totals		404,741.38	57,311.03	158,468.06	620,520.47
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Dry Cargo	Large	.00	.00	.01	.01
Dry Cargo	Medium	.01	.00	.01	.01
Dry Cargo	Small	.18	.03	.05	.26
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.01	.00	.01	.03
Tug/Tow Boat	Small	.01	.00	.01	.01
Totals		.21	.04	.09	.34
Existing VTS Design - Dollars					
Passenger	Medium	41.10	0.00	73.58	114.68
Dry Cargo	Large	970.96	230.57	1,967.09	3,168.63
Dry Cargo	Medium	1,856.99	417.70	1,209.02	3,483.71
Dry Cargo	Small	41,860.19	6,896.85	12,574.58	61,331.62
Tanker	Small	300.80	0.00	405.60	706.40
Dry Cargo Barge Tow	Small	1,091.91	478.99	751.93	2,322.82
Tanker Barge Tow	Small	2,705.84	685.03	3,130.35	6,521.23
Tug/Tow Boat	Small	1,209.65	594.82	1,525.82	3,330.28
Totals		50,037.44	9,303.97	21,637.97	80,979.37

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.49	.05	.15	.69
Dry Cargo	Large	.52	.08	.09	.70
Dry Cargo	Medium	.66	.11	.04	.81
Dry Cargo	Small	1.22	.12	.15	1.49
Tanker	Large	.09	.02	.02	.14
Tanker	Medium	.03	.00	.00	.04
Tanker	Small	.03	0.00	.03	.06
Dry Cargo Barge Tow	Large	.26	0.00	.07	.33
Dry Cargo Barge Tow	Small	3.75	.63	.27	4.65
Tanker Barge Tow	Large	.03	.01	.00	.04
Tanker Barge Tow	Small	.64	.07	.09	.80
Tug/Tow Boat	Small	.11	.02	.06	.20
Totals		7.84	1.12	.99	9.95
Candidate VTS Design - Dollars					
Passenger	Medium	9,682.71	0.00	7,884.84	17,567.55
Passenger	Small	167,803.45	18,704.24	74,841.04	261,348.73
Dry Cargo	Large	383,641.67	62,546.85	53,424.54	499,613.06
Dry Cargo	Medium	589,191.24	95,895.23	18,227.22	703,313.69
Dry Cargo	Small	231,558.21	22,506.28	38,380.27	292,444.77
Tanker	Large	70,989.68	17,750.15	51,097.79	139,837.62
Tanker	Medium	19,991.43	2,068.94	6,601.40	28,661.77
Tanker	Small	9,506.68	0.00	9,968.63	19,475.31
Dry Cargo Barge Tow	Large	33,494.45	0.00	7,282.84	40,777.29
Dry Cargo Barge Tow	Small	217,590.10	36,588.73	13,673.74	267,852.57
Tanker Barge Tow	Large	4,298.24	1,217.99	972.42	6,488.66
Tanker Barge Tow	Small	45,462.59	4,635.23	8,214.88	58,312.70
Tug/Tow Boat	Small	8,036.42	1,780.29	5,893.76	15,710.46
Totals		1,791,246.89	263,693.92	296,463.37	2,351,404.18
Existing VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Dry Cargo	Large	.22	.05	.06	.33
Dry Cargo	Medium	.43	.09	.04	.55
Dry Cargo	Small	.20	.03	.04	.26
Tanker	Large	.04	.02	.02	.08
Tanker	Medium	.02	.00	.00	.02
Tanker	Small	.01	0.00	.02	.03
Dry Cargo Barge Tow	Large	.32	0.00	.10	.42
Dry Cargo Barge Tow	Small	.14	.04	.02	.20
Tanker Barge Tow	Large	.02	.01	.01	.04
Tanker Barge Tow	Small	.36	.05	.08	.48
Tug/Tow Boat	Small	.04	.01	.03	.08
Totals		1.81	.29	.41	2.51
Existing VTS Design - Dollars					
Passenger	Medium	8,234.22	0.00	8,560.98	16,795.20
Dry Cargo	Large	164,367.53	37,353.87	35,280.99	237,002.40
Dry Cargo	Medium	379,777.59	81,752.08	16,212.36	477,742.04
Dry Cargo	Small	37,662.55	5,045.70	9,352.31	52,060.56
Tanker	Large	35,114.41	12,057.89	37,731.52	84,903.83
Tanker	Medium	11,483.73	1,598.85	5,419.98	18,502.56
Tanker	Small	3,411.73	0.00	6,000.49	9,412.22
Dry Cargo Barge Tow	Large	41,197.26	0.00	9,906.75	51,104.02
Dry Cargo Barge Tow	Small	8,375.33	2,034.38	920.87	11,330.58
Tanker Barge Tow	Large	3,673.56	1,323.35	1,059.26	6,056.16
Tanker Barge Tow	Small	25,356.38	3,554.58	6,810.87	35,721.84
Tug/Tow Boat	Small	2,641.46	834.26	3,239.86	6,715.57
Totals		721,295.76	145,554.97	140,496.23	1,007,346.96

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.13	.02	.04	.19
Dry Cargo	Large	.21	.05	.12	.38
Dry Cargo	Medium	.27	.06	.05	.38
Dry Cargo	Small	.55	.06	.07	.68
Tanker	Large	.04	.01	.02	.07
Tanker	Medium	.01	.00	.00	.02
Tanker	Small	.04	0.00	.02	.05
Dry Cargo Tow	Large	.03	0.00	.04	.07
Dry Cargo Tow	Small	1.04	.31	.17	1.52
Tanker Tow	Large	.00	.00	.00	.01
Tanker Tow	Small	.18	.03	.06	.27
Tug/Tow Boat	Small	.05	.02	.02	.09
Totals		2.56	.56	.61	3.72
Candidate VTS Design - Dollars					
Passenger	Medium	42.60	0.00	24.54	67.14
Passenger	Small	424.36	47.30	169.02	640.68
Dry Cargo	Large	1,975.19	476.74	245.50	2,697.43
Dry Cargo	Medium	2,510.93	605.02	112.03	3,227.98
Dry Cargo	Small	1,050.87	102.14	172.29	1,325.30
Tanker	Large	802.97	196.65	759.74	1,759.36
Tanker	Medium	133.83	13.77	23.30	170.91
Tanker	Small	77.03	0.00	46.24	123.27
Tanker Tow	Large	711.86	368.26	575.19	1,655.31
Tanker Tow	Small	10,933.81	2,015.18	3,475.76	16,424.75
Tug/Tow Boat	Small	96.74	21.43	69.06	187.23
Totals		18,760.20	3,846.47	5,672.67	28,279.35
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Dry Cargo	Large	.09	.03	.08	.20
Dry Cargo	Medium	.18	.05	.05	.27
Dry Cargo	Small	.09	.01	.02	.12
Tanker	Large	.02	.01	.02	.04
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Large	.04	0.00	.05	.09
Dry Cargo Tow	Small	.04	.02	.01	.07
Tanker Tow	Large	.00	.00	.00	.01
Tanker Tow	Small	.10	.03	.05	.17
Tug/Tow Boat	Small	.02	.01	.01	.03
Totals		.60	.15	.30	1.05
Existing VTS Design - Dollars					
Passenger	Medium	36.22	0.00	26.65	62.87
Dry Cargo	Large	846.25	284.71	162.12	1,293.09
Dry Cargo	Medium	1,618.48	515.78	99.65	2,233.91
Dry Cargo	Small	170.92	22.90	41.98	235.80
Tanker	Large	441.48	146.36	634.03	1,221.87
Tanker	Medium	78.46	10.82	20.27	109.55
Tanker	Small	28.76	0.00	28.34	57.10
Tanker Tow	Large	622.44	407.68	635.92	1,666.03
Tanker Tow	Small	6,216.23	1,573.75	2,928.68	10,718.67
Tug/Tow Boat	Small	31.80	10.04	37.96	79.80
Totals		10,091.04	2,972.05	4,615.60	17,678.70

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.01	.01	.02
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.02	.00	.02
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.17	.01	.18
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.02	.00	.02
Tug/Tow Boat	Small	0.00	.03	.00	.03
Totals		0.00	.28	.03	.31
Candidate VTS Design - Dollars					
Passenger	Small	0.00	53.18	15.03	68.20
Dry Cargo	Large	0.00	77.17	29.80	106.97
Dry Cargo	Medium	0.00	97.93	13.60	111.53
Dry Cargo	Small	0.00	109.84	9.22	119.06
Tanker	Large	0.00	18.22	5.85	24.07
Tanker	Medium	0.00	2.52	.91	3.43
Tanker	Small	0.00	0.00	3.77	3.77
Dry Cargo Barge Tow	Large	0.00	0.00	11.64	11.64
Dry Cargo Barge Tow	Small	0.00	962.81	62.47	1,025.28
Tanker Barge Tow	Large	0.00	9.65	.79	10.44
Tanker Barge Tow	Small	0.00	99.84	21.12	120.96
Tug/Tow Boat	Small	0.00	141.86	15.53	157.39
Totals		0.00	1,573.02	189.73	1,762.74
Existing VTS Design - Counts					
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.01	.00	.02
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.01	.00	.01
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.01	.00	.02
Tug/Tow Boat	Small	0.00	.01	.00	.01
Totals		0.00	.07	.02	.08
Existing VTS Design - Dollars					
Dry Cargo	Large	0.00	46.09	19.68	65.77
Dry Cargo	Medium	0.00	83.49	12.10	95.58
Dry Cargo	Small	0.00	24.62	2.25	26.87
Tanker	Large	0.00	12.38	4.32	16.70
Tanker	Medium	0.00	1.95	.74	2.69
Tanker	Small	0.00	0.00	2.27	2.27
Dry Cargo Barge Tow	Large	0.00	0.00	15.83	15.83
Dry Cargo Barge Tow	Small	0.00	53.53	4.21	57.74
Tanker Barge Tow	Large	0.00	10.49	.86	11.34
Tanker Barge Tow	Small	0.00	76.56	17.51	94.08
Tug/Tow Boat	Small	0.00	66.48	8.54	75.02
Totals		0.00	375.58	88.31	463.89

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16   Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.02
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.05	0.00	.05
Candidate VTS Design - Dollars					
Passenger	Small	1,586.86	10,175.35	0.00	11,762.21
Dry Cargo	Large	0.00	10,896.68	0.00	10,896.68
Dry Cargo	Medium	0.00	19,740.25	0.00	19,740.25
Dry Cargo	Small	527.17	3,120.44	0.00	3,647.61
Tanker	Large	0.00	2,926.91	0.00	2,926.91
Tanker	Medium	0.00	460.93	0.00	460.93
Tanker	Small	111.54	0.00	0.00	111.54
Dry Cargo Barge Tow	Small	2,071.93	28,116.18	0.00	30,188.10
Tanker Barge Tow	Large	0.00	2,479.45	0.00	2,479.45
Tanker Barge Tow	Small	1,157.27	10,381.43	0.00	11,538.70
Tug/Tow Boat	Small	507.46	8,854.74	0.00	9,362.20
Totals		5,962.22	97,152.34	0.00	103,114.57
Existing VTS Design - Counts					
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.01
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.01	0.00	.01
Totals		.00	.05	0.00	.05
Existing VTS Design - Dollars					
Dry Cargo	Large	0.00	15,812.85	0.00	15,812.85
Dry Cargo	Medium	0.00	28,646.32	0.00	28,646.32
Dry Cargo	Small	644.11	4,771.74	0.00	5,415.85
Tanker	Large	0.00	4,247.42	0.00	4,247.42
Tanker	Medium	0.00	668.88	0.00	668.88
Tanker	Small	137.02	0.00	0.00	137.02
Dry Cargo Barge Tow	Small	525.94	10,373.78	0.00	10,899.72
Tanker Barge Tow	Large	0.00	3,598.08	0.00	3,598.08
Tanker Barge Tow	Small	1,303.32	14,836.27	0.00	16,139.59
Tug/Tow Boat	Small	576.62	12,749.15	0.00	13,325.77
Totals		3,187.01	95,704.49	0.00	98,891.50

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	.00	.00	.00	.00	.00
ALCOHOLS	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.02	.00	.02
GASOLINE, INCL NATURAL	.00	.01	.03	.00	.04
DISTILLATE FUEL OIL	.00	.01	.02	.53	.56
CRUDE PETROLEUM	.00	.00	.00	.00	.01
RESIDUAL FUEL OIL	.00	.02	.20	.32	.54
	.01	.04	.27	.86	1.18
Existing Vts Design - Counts					
BENZENE AND TOLUENE	.00	.00	.00	.00	.00
ALCOHOLS	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.01
GASOLINE, INCL NATURAL	.00	.00	.02	.00	.02
DISTILLATE FUEL OIL	.00	.00	.02	.08	.10
CRUDE PETROLEUM	.00	.00	.00	.00	.01
RESIDUAL FUEL OIL	.00	.01	.12	.19	.33
	.01	.03	.16	.28	.48

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix H Zone 8 Chesapeake South/Hampton Roads, VA
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	13,186	0	0
1996	0	1,163	489
1997	0	1,057	452
1998	0	961	418
1999	0	874	386
2000	0	794	357
2001	0	722	331
2002	0	657	308
2003	0	597	285
2004	0	543	265
2005	0	493	246
2006	0	448	229
2007	0	408	213
2008	0	371	198
2009	0	337	184
2010	0	306	171
	13,186	9,732	4,531

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	13,186	0	0
1996	0	1,478	621
1997	0	1,478	632
1998	0	1,478	642
1999	0	1,478	653
2000	0	1,478	664
2001	0	1,478	678
2002	0	1,478	692
2003	0	1,478	707
2004	0	1,478	721
2005	0	1,478	736
2006	0	1,478	753
2007	0	1,478	771
2008	0	1,478	789
2009	0	1,478	807
2010	0	1,478	825
	13,186	22,167	10,692

Appendix H TABLE 18B

Zone 8 Chesapeake South/Hampton Roads, VA
Annual Benefit & Cost Streams
Existing VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	256
1997	0	0	238
1998	0	0	220
1999	0	0	204
2000	0	0	189
2001	0	0	176
2002	0	0	163
2003	0	0	152
2004	0	0	141
2005	0	0	131
2006	0	0	122
2007	0	0	114
2008	0	0	106
2009	0	0	99
2010	0	0	92
	0	0	2,402

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	326
1997	0	0	332
1998	0	0	338
1999	0	0	345
2000	0	0	351
2001	0	0	359
2002	0	0	368
2003	0	0	376
2004	0	0	385
2005	0	0	393
2006	0	0	403
2007	0	0	413
2008	0	0	423
2009	0	0	433
2010	0	0	443
	0	0	5,687

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads Port & Subzone	Species Category	(Port 8) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0801	101	1	American Shad	.3528	.3528	0.0000	0.0000
0801	101	2	Alewife	.5311	.5311	0.0000	0.0000
0801	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0801	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0801	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0801	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0801	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0801	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0801	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0801	102	34	Harvestfish	.0010	.0010	.0010	.0010
0801	103	9	Striped Bass	.0567	.0567	.0567	.0567
0801	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0801	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0801	105	18	Amarican Plaice	.0170	.0090	.0090	.0100
0801	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0801	106	24	Silver Hake	.0010	.0010	.0010	.0010
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	25	Red Hake	.0040	.0020	.0030	.0030
0801	106	26	White Hake	.0090	.0140	.0050	0.0000
0801	106	28	Tilefish	.0330	.0330	.0330	.0330
0801	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0801	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0801	106	36	Black Drum	.0059	.0059	.0059	.0059
0801	106	37	Spot	.0960	.0490	0.0000	.0490
0801	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0801	106	39	Carp	.0250	.0250	.0250	.0250
0801	106	40	Eel	.1400	.1400	.1400	.1400
0801	106	48	Catfish	.1647	.1647	.1647	.1647
0801	106	123	White Perch	.0682	.0682	.0682	.0682
0801	106	124	Spot	.1182	.1182	.1182	0.0000
0801	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0801	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
0801	107	203	Scallop	.0600	.0600	.0600	.0600
0801	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0801	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0801	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0801	107	213	Hard Clam	.0800	.0800	.0800	.0800
0801	107	214	Conch	.0660	.0660	.0660	.0660
0801	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0801	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0801	108	206	Red Crab	.2300	.2300	.2300	.2300
0801	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0801	109	207	Squid	.0280	.1500	.1300	0.0000
0802	101	1	American Shad	.3528	.3528	0.0000	0.0000
0802	101	2	Alewife	.5311	.5311	0.0000	0.0000
0802	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0802	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0802	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0802	102	4	Atlantic Herring	.0010	.0010	.0010	.0010

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads (Port 8)

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0802	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0802	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0802	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0802	102	34	Harvestfish	.0010	.0010	.0010	.0010
0802	103	9	Striped Bass	.0567	.0567	.0567	.0567
0802	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0802	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0802	105	18	American Plaice	.0170	.0090	.0090	.0100
0802	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0802	106	24	Silver Hake	.0010	.0010	.0010	.0010
0802	106	26	White Hake	.0090	.0140	.0050	0.0000
0802	106	28	Tilefish	.0330	.0330	.0330	.0330
0802	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0802	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0802	106	36	Black Drum	.0059	.0059	.0059	.0059
0802	106	37	Spot	.0960	.0490	0.0000	.0490
0802	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0802	106	39	Carp	.0250	.0250	.0250	.0250
0802	106	40	Eel	.1400	.1400	.1400	.1400
0802	106	48	Catfish	.1647	.1647	.1647	.1647
0802	106	123	White Perch	.0682	.0682	.0682	.0682
0802	106	124	Spot	.1182	.1182	.1182	0.0000
0802	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0802	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
0802	107	203	Scallop	.0600	.0600	.0600	.0600
0802	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0802	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0802	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0802	107	213	Hard Clam	.0800	.0800	.0800	.0800
0802	107	214	Conch	.0660	.0660	.0660	.0660
0802	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0802	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0802	108	206	Red Crab	.2300	.2300	.2300	.2300
0802	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0802	109	207	Squid	.0280	.1500	.1300	0.0000
0803	101	1	American Shad	.3528	.3528	0.0000	0.0000
0803	101	2	Alewife	.5311	.5311	0.0000	0.0000
0803	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0803	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0803	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0803	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0803	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0803	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0803	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0803	102	34	Harvestfish	.0010	.0010	.0010	.0010
0803	103	9	Striped Bass	.0567	.0567	.0567	.0567
0803	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0803	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0803	105	18	American Plaice	.0170	.0090	.0090	.0100
0803	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0803	106	24	Silver Hake	.0010	.0010	.0010	.0010
0803	106	26	White Hake	.0090	.0140	.0050	0.0000
0803	106	28	Tilefish	.0330	.0330	.0330	.0330

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads Port & Subzone	Species Category	(Port 8) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0803	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0803	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0803	106	36	Black Drum	.0059	.0059	.0059	.0059
0803	106	37	Spot	.0960	.0490	0.0000	.0490
0803	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0803	106	39	Carp	.0250	.0250	.0250	.0250
0803	106	40	Eel	.1400	.1400	.1400	.1400
0803	106	48	Catfish	.1647	.1647	.1647	.1647
0803	106	123	White Perch	.0682	.0682	.0682	.0682
0803	106	124	Spot	.1182	.1182	.1182	0.0000
0803	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0803	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
0803	107	203	Scallop	.0600	.0600	.0600	.0600
0803	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0803	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0803	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0803	107	213	Hard Clam	.0800	.0800	.0800	.0800
0803	107	214	Conch	.0660	.0660	.0660	.0660
0803	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0803	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0803	108	206	Red Crab	.2300	.2300	.2300	.2300
0803	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0803	109	207	Squid	.0280	.1500	.1300	0.0000
0804	101	1	American Shad	.3528	.3528	0.0000	0.0000
0804	101	2	Alewife	.5311	.5311	0.0000	0.0000
0804	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0804	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0804	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0804	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0804	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0804	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0804	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0804	102	34	Harvestfish	.0010	.0010	.0010	.0010
0804	103	9	Striped Bass	.0567	.0567	.0567	.0567
0804	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0804	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0804	105	18	Amarican Plaice	.0170	.0090	.0090	.0100
0804	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0804	106	24	Silver Hake	.0010	.0010	.0010	.0010
0804	106	26	White Hake	.0090	.0140	.0050	0.0000
0804	106	28	Tilefish	.0330	.0330	.0330	.0330
0804	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0804	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0804	106	36	Black Drum	.0059	.0059	.0059	.0059
0804	106	37	Spot	.0960	.0490	0.0000	.0490
0804	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0804	106	39	Carp	.0250	.0250	.0250	.0250
0804	106	40	Eel	.1400	.1400	.1400	.1400
0804	106	48	Catfish	.1647	.1647	.1647	.1647
0804	106	123	White Perch	.0682	.0682	.0682	.0682
0804	106	124	Spot	.1182	.1182	.1182	0.0000
0804	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0804	107	202	Quahog	7.2000	7.2000	7.2000	7.2000

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads Port & Subzone	Species Category	(Port 8) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0804	107	203	Scallop	.0600	.0600	.0600	.0600
0804	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0804	107	211	Soft Snell Clam	.1362	.1362	.1362	.1362
0804	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0804	107	213	Hard Clam	.0800	.0800	.0800	.0800
0804	107	214	Conch	.0660	.0660	.0660	.0660
0804	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0804	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0804	108	206	Red Crab	.2300	.2300	.2300	.2300
0804	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0804	109	207	Squid	.0280	.1500	.1300	0.0000
0805	101	1	American Shad	.3528	.3528	0.0000	0.0000
0805	101	2	Alewife	.5311	.5311	0.0000	0.0000
0805	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0805	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0805	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0805	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0805	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0805	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0805	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0805	102	34	Harvestfish	.0010	.0010	.0010	.0010
0805	103	9	Striped Bass	.0567	.0567	.0567	.0567
0805	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0805	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0805	105	18	Amarican Plaice	.0170	.0090	.0090	.0100
0805	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0805	106	24	Silver Hake	.0010	.0010	.0010	.0010
0805	106	26	White Hake	.0090	.0140	.0050	0.0000
0805	106	28	Tilefish	.0330	.0330	.0330	.0330
0805	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0805	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0805	106	36	Black Drum	.0059	.0059	.0059	.0059
0805	106	37	Spot	.0960	.0490	0.0000	.0490
0805	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0805	106	39	Carp	.0250	.0250	.0250	.0250
0805	106	40	Eel	.1400	.1400	.1400	.1400
0805	106	48	Catfish	.1647	.1647	.1647	.1647
0805	106	123	White Perch	.0682	.0682	.0682	.0682
0805	106	124	Spot	.1182	.1182	.1182	0.0000
0805	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0805	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
0805	107	203	Scallop	.0600	.0600	.0600	.0600
0805	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0805	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0805	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0805	107	213	Hard Clam	.0800	.0800	.0800	.0800
0805	107	214	Conch	.0660	.0660	.0660	.0660
0805	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0805	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0805	108	206	Red Crab	.2300	.2300	.2300	.2300
0805	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0805	109	207	Squid	.0280	.1500	.1300	0.0000
0806	101	1	American Shad	.3528	.3528	0.0000	0.0000

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads Port & Subzone	Species Category	(Port 8) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0806	101	2	Alewife	.5311	.5311	0.0000	0.0000
0806	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0806	101	122	Hickory Shad	.0011	.0011	.0011	.0011
0806	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0806	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0806	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0806	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0806	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0806	102	34	Harvestfish	.0010	.0010	.0010	.0010
0806	103	9	Striped Bass	.0567	.0567	.0567	.0567
0806	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0806	105	17	Summer Flounder	.0270	.0010	.0350	.0940
0806	105	18	Amarican Plaice	.0170	.0090	.0090	.0100
0806	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0806	106	24	Silver Hake	.0010	.0010	.0010	.0010
0806	106	26	White Hake	.0090	.0140	.0050	0.0000
0806	106	28	Tilefish	.0330	.0330	.0330	.0330
0806	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
0806	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0806	106	36	Black Drum	.0059	.0059	.0059	.0059
0806	106	37	Spot	.0960	.0490	0.0000	.0490
0806	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0806	106	39	Carp	.0250	.0250	.0250	.0250
0806	106	40	Eel	.1400	.1400	.1400	.1400
0806	106	48	Catfish	.1647	.1647	.1647	.1647
0806	106	123	White Perch	.0682	.0682	.0682	.0682
0806	106	124	Spot	.1182	.1182	.1182	0.0000
0806	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
0806	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
0806	107	203	Scallop	.0600	.0600	.0600	.0600
0806	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0806	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0806	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0806	107	213	Hard Clam	.0800	.0800	.0800	.0800
0806	107	214	Conch	.0660	.0660	.0660	.0660
0806	107	232	Bay Scallop	32.0000	105.5000	148.0000	32.0000
0806	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0806	108	206	Red Crab	.2300	.2300	.2300	.2300
0806	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0806	109	207	Squid	.0280	.1500	.1300	0.0000

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads		(Port 8)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0801	2	1199	larvae	.1900	.8100	.8100	.2200
0801	3	1199	larvae	.0110	.1900	.0054	0.0000
0801	5	1199	larvae	1.1000	.6600	.3600	.0040
0801	6	1199	larvae	.0270	.4700	1.0400	.0200
0801	7	1199	larvae	2.0000	20.0000	2.0000	0.0000
0801	8	1199	larvae	.0016	.0042	0.0000	0.0000
0802	2	1199	larvae	.1900	.8100	.8100	.2200
0802	3	1199	larvae	.0110	.1900	.0054	0.0000
0802	5	1199	larvae	1.1000	.6600	.3600	.0040
0802	6	1199	larvae	.0270	.4700	1.0400	.0200
0802	7	1199	larvae	2.0000	20.0000	2.0000	0.0000
0802	8	1199	larvae	.0016	.0042	0.0000	0.0000
0803	2	1043	Bay Anchovy	109.8000	240.3000	0.0000	0.0000
0803	2	1120	Goby	.0550	47.9400	0.0000	0.0000
0803	2	1121	Feather Blenny	.0900	20.4500	0.0000	0.0000
0803	2	1199	larvae	12.4000	52.7000	53.4000	14.3000
0803	3	1011	Weakfish	.9000	30.2600	0.0000	0.0000
0803	3	1199	larvae	.0640	1.1000	.0310	0.0000
0803	5	1199	larvae	10.9000	6.5000	3.6000	.0400
0803	6	1199	larvae	.2100	3.6000	8.0000	.1500
0803	7	1199	larvae	100.0000	1000.0000	100.0000	0.0000
0803	8	1199	larvae	.0160	.0420	0.0000	0.0000

APPENDIX H

ZONE 8 - CHESAPEAKE SOUTH/HAMPTON ROADS, VA (Cont.)

STUDY SUZ-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Hampton Roads Port & Subzone	Species Category	(Port 8) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0801	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0801	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0801	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0801	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0801	11	516	Loons	.7700	0.0000	.0100	.0400
0801	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0801	13	531	Gulls	5.6200	.1200	3.8500	3.7300
0801	13	532	Kittiwakes	.0400	0.0000	.0500	.7700
0801	13	533	Terns	.1400	.1200	.5200	0.0000
0801	13	534	Shearwater	.0500	.9700	.3600	0.0000
0801	13	535	Jaegers	.0400	.0100	.1200	0.0000
0801	13	536	Fulmars	.5000	0.0000	0.0000	0.0000
0801	13	537	Storm Petrels	6.0800	1.6400	.1000	0.0000
0801	13	542	Phalaropes	11.6000	.0200	.4500	0.0000
0801	13	547	Gannets, Boobies	1.5700	0.0000	.2100	.7000
0801	14	581	Osprey	.1930	.1930	.1930	.1930
0802	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0802	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0802	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0802	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0802	11	516	Loons	.7700	0.0000	.0100	.0400
0802	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0802	13	531	Gulls	5.6200	.1200	3.8500	3.7300
0802	13	532	Kittiwakes	.0400	0.0000	.0500	.7700
0802	13	533	Terns	.1400	.1200	.5200	0.0000
0802	13	534	Shearwater	.0500	.9700	.3600	0.0000
0802	13	535	Jaegers	.0400	.0100	.1200	0.0000
0802	13	536	Fulmars	.5000	0.0000	0.0000	0.0000
0802	13	537	Storm Petrels	6.0800	1.6400	.1000	0.0000
0802	13	542	Phalaropes	11.6000	.0200	.4500	0.0000
0802	13	547	Gannets, Boobies	1.5700	0.0000	.2100	.7000
0802	14	581	Osprey	.1930	.1930	.1930	.1930
0803	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0803	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0803	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0803	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0803	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0803	14	581	Osprey	.1930	.1930	.1930	.1930
0804	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0804	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0804	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0804	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0804	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0804	14	581	Osprey	.1930	.1930	.1930	.1930
0805	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0805	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0805	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0805	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0805	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0805	14	581	Osprey	.1930	.1930	.1930	.1930
0806	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0806	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0806	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0806	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0806	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0806	14	581	Osprey	.1930	.1930	.1930	.1930

APPENDIX I

CHESAPEAKE NORTH/BALTIMORE, MD

(ZONE 9)

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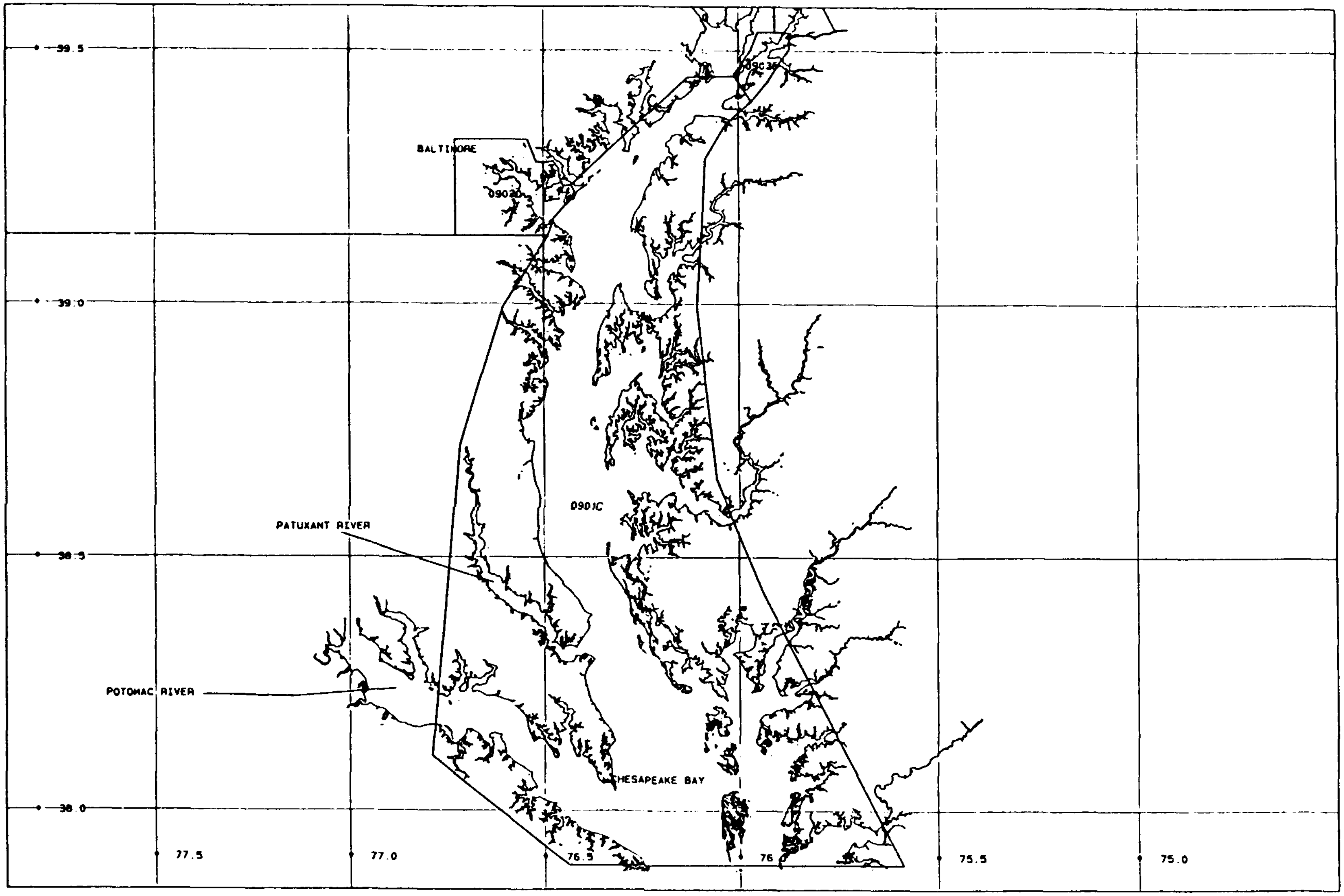
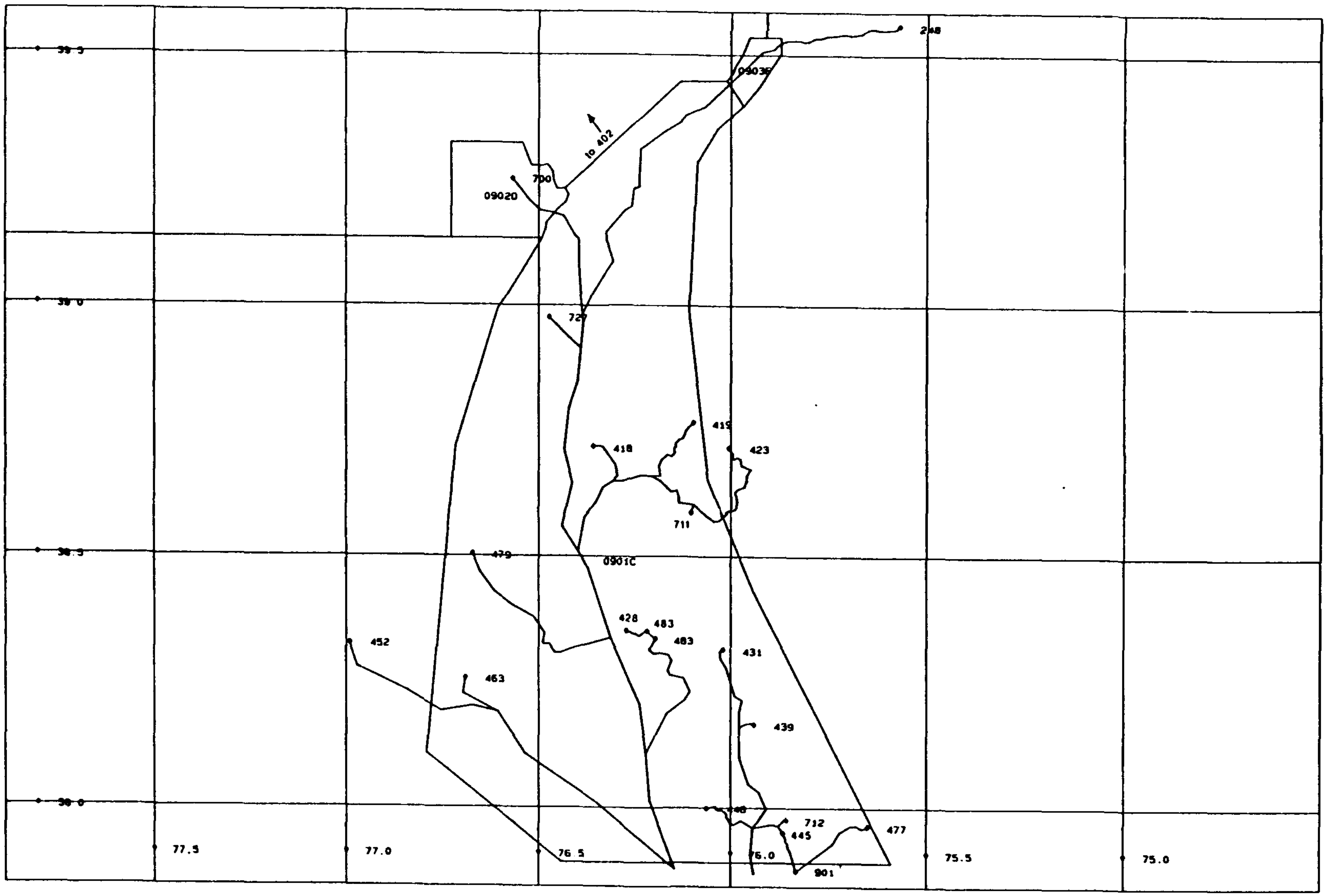
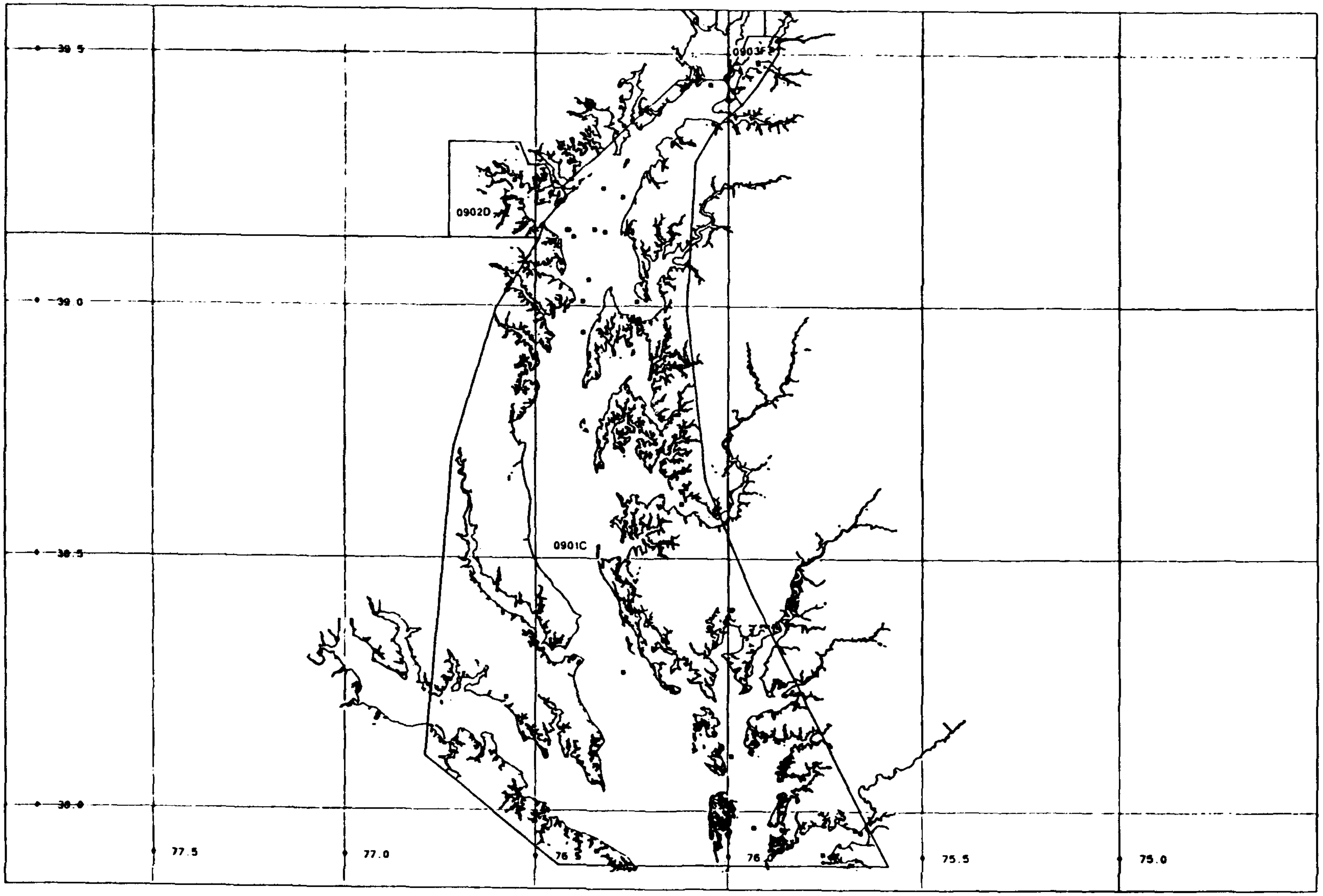
STUDY ZONE MAPS



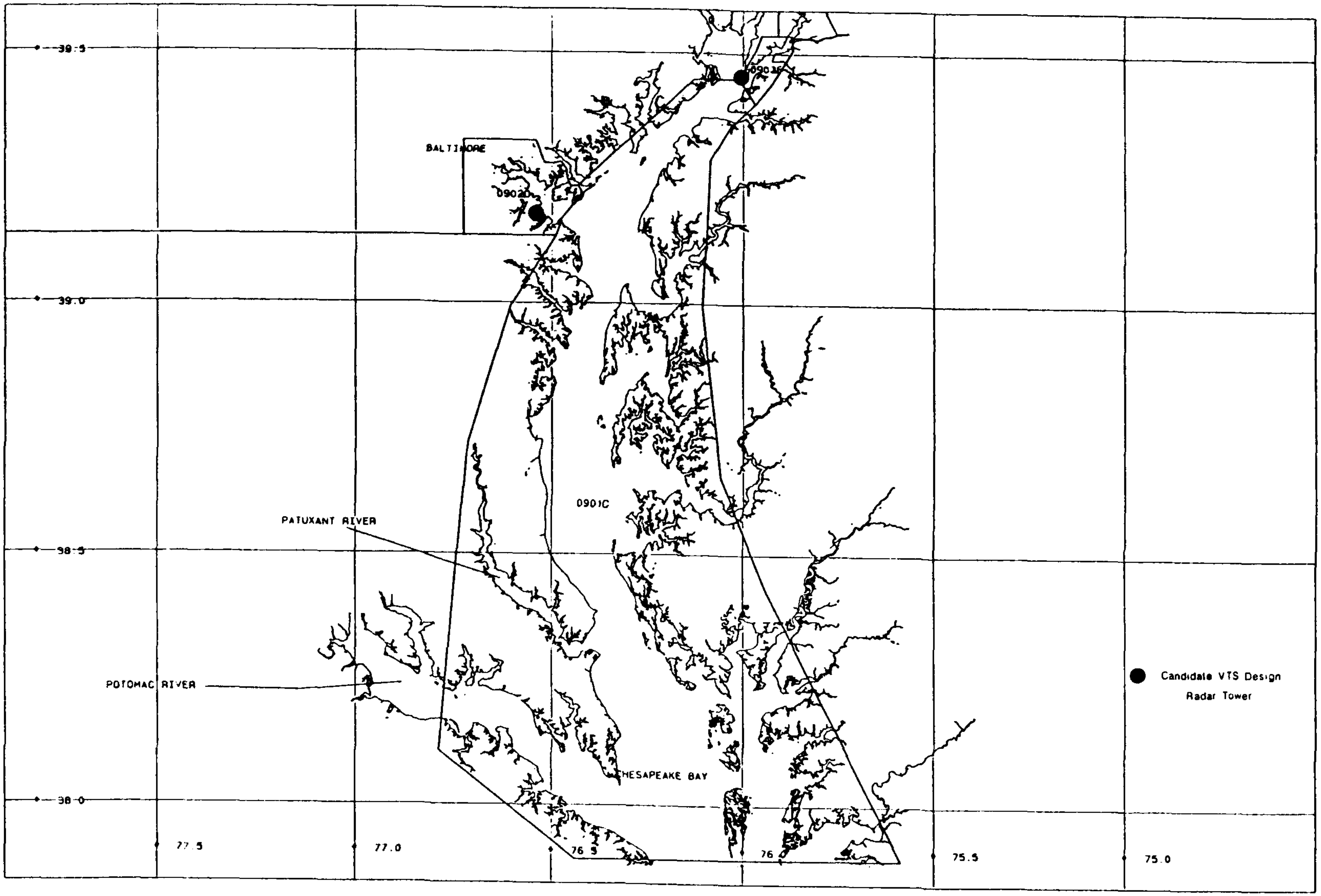
ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD - ZONE AND SUBZONE BOUNDARIES



ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

CHESAPEAKE NORTH/BALTIMORE, MD

(ZONE 9)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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BALTIMORE PORT VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for the Port of Baltimore, Maryland. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 BALTIMORE PORT SURVEY

2.1. INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Baltimore, related areas such as Curtis Bay, and the approaches from Upper and Lower Chesapeake Bay. Baltimore is one of the major ports of the United States and is in active competition with other East Coast ports for trade. Principal imports by sea are general cargo, petroleum, ores, lumber and motor vehicles. Exports are general cargoes, grains, coal and chemicals. Coastwise trade is primarily in petroleum products. The port ranks ninth in the United States in the number of barge movements (Reference 1).

Baltimore sits near the head of the environmentally sensitive Chesapeake Bay and the area is densely populated.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is midway between northern and southern extremes, and is further moderated by proximity to Chesapeake Bay. While average winter temperatures may be mild, the area experiences periods of cold weather sufficient to cause disruption of traffic as the result of icing. During severe winters ice movement can disturb or cause removal of buoys. Fog is generally not a problem between April and September, and the number of days in which visibility lowers to less than 0.25 mile during the rest of the year is about four days per month (Reference 2).

The diurnal tidal range is 1.1 feet at Baltimore proper, with tidal current velocities approaching 0.8 knots at maximum ebb. Tide does play an important role in the movement of ships between Baltimore and the Virginia Capes and reference should be made to tide tables, and the "Survey Report for Chesapeake Bay".

A Federal project provides 42' channels between the Virginia Capes and Fort McHenry (Baltimore). Project depth in the northern approach via the Chesapeake and Delaware (C&D) Canal is 35'. Chart tabulations should be consulted for the actual Project dimensions of each of the numerous individual channels. Channels are well marked by buoys and fixed aids to navigation, including ranges.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S.-flag ships in the coastwise trade with a federally licensed pilot on board.

The Association of Maryland Pilots provides pilotage between Baltimore and the Virginia Capes, and between Baltimore and the Maryland entrance to the C&D Canal. Communications are via VHF-FM channels 11, 14, 16, and 74. The Virginia Capes Pilot Station monitors CH13 but does not transmit on it.

The Chesapeake and Interstate Pilots Association offers pilotage to public and U. S.-Flag coastwise ships in the coastwise trade to and from Baltimore via the Virginia Capes, the C&D Canal and ports within Chesapeake Bay.

The Association of East Coast Pilots offers pilotage to public and U. S.-Flag coastwise ships between Baltimore and the C&D Canal, and selected Northeast ports.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Regulated Navigation Area

33CFR165.503 provides for the establishment of a Regulated Navigation Area during periods when ice may affect navigation in the Upper Chesapeake. Imposition is ordered by COTP Baltimore when conditions warrant and is removed by COTP action when no longer required. Basically, when effective, vessels subject to its provisions which intend to operate within the Regulated Navigation Area are required to be capable of complying with specific COTP Orders dealing with movements and comply with them when underway. See 33CFR165.503 or the Coast Pilot (Reference 3) for further details.

2.3.2 Anchorages

A total of seven Federal Anchorages have been established by 33CFR110.158 within the Study Area. Anchorages, with the exception of a Dead Ship Anchorage in Curtis Bay, are all General Anchorages. A series of general regulations governing operation in the anchorages is contained in the CFR, and it or the Coast Pilot (Reference 4) should be consulted for details.

2.4 VESSEL TRAFFIC

In 1987, the Port of Baltimore handled 37.5 million tons of cargo, 4.7 million tons of which were petroleum products (jet fuel, gasoline and heating oil). There were 1667 tank ship and 4974 tank barge movements within the port that year (Reference 5). At present, traffic levels within the port average 430 moves by piloted vessels of all types. Of these, relatively few are intra-port movements.

There has been a downward trend in the volume of vessel traffic during the past few years, primarily a reflection of the increase in size of ships. Another factor is that intra-Chesapeake and Delaware Bay transportation is shifting away from relatively small self-propelled ships to barges. Details of barge traffic are unavailable, except for the tank barge data cited above.

The relative volume between traffic using the northern and southern approaches to Baltimore is unknown but it is felt that deeply laden ships movements are confined to the southern area. The limiting factors for northern movement is the C&D Canal, where limiting draft is 35' and ships whose combined beams equal or exceed 190' may not meet in the Canal.

Recreational traffic throughout the Study Area is significant but tends not to interfere with commerce.

2.5 ENVIRONMENTAL SENSITIVITY

The Baltimore area, particularly the upper reaches of Chesapeake Bay, contains tide- and wetlands of major importance to the maintenance of aquatic bird populations along the entire Eastern Seaboard. Its shoal water areas support major fisheries in shellfish, including crab and oysters. Spills of petroleum products and/or hazardous substances would have a major effect upon these areas. Collision between a ship and a tank barge, or between a petrochemical carrier and another ship, represent the "worse case" scenarios of the U. S. Coast Guard Captain of the Port (COTP), Baltimore.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 6). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Northern Chesapeake Bay

Sub-Zone I consists of that portion of Chesapeake Bay lying south of the William P. Lane, Jr. Memorial Bridge.

The sub-zone functions essentially as a data catchment area for shipping entering the Baltimore VTS Zone from the south. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

It should be noted that the northern portion of this sub-zone equates to Sub-zone IV of Chesapeake Bay.

The Sub-Zone is assigned a dual rating. For shoal draft traffic it is "open-simple," but for deep-draft traffic constrained by draft it is "confined-simple."

2.6.2 Sub-Zone II -- Northern Approaches

Sub-Zone II consists of that portion of Upper Chesapeake Bay north of a line drawn between Pooles Island Rear Range and the towers on Plum Point.

The sub-zone functions essentially as a data catchment area for shipping entering the Baltimore VTS Zone from the north. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-simple."

2.6.3 Sub-Zone III -- Outer Baltimore Harbor (NOAA Charts 12273 & 12278)

Sub-Zone III consists of that portion of Chesapeake Bay and the Patapsco lying north of the upper boundary of Sub-zone I (the William P. Lane, Jr. Memorial Bridge), south of the lower limit of Sub-zone II (a line drawn between Pooles Island Rear Range and the towers on Plum Point) and the Francis Scott Key Bridge (connecting Hawkins Point and Sollers Point).

The sub-zone contains a series of federally maintained channels, some of which are quite narrow and/or bounded by shoal water. Although well marked by aids to navigation, including buoys and fixed aids, winter ice can disrupt buoys and poor visibility obscure fixed aids. Dissimilar traffic tends to share the same waterway, particularly toward the western limit of the sub-zone. The VTC should have real-time information about vessel positions and movement, and be able to provide both navigational assistance and movement management advice.

The sub-zone is "confined-complex."

2.6.4 Sub-Zone IV -- Baltimore Harbor (NOAA Chart 12281)

The sub-zone consists of that portion of the Port of Baltimore lying west of the Francis Scott Key Bridge (connecting Hawkins Point and Sollers Point). It includes Curtis Bay to the Highway Bridge.

The sub-zone contains a comparatively high density of facilities plus the maneuvering area for ships approaching and departing from them. The VTC should be capable of providing movement management advice, including such regulation of the outbound queue as may from time to time be required. The sub-zone contains a number of anchorages, which may require management.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

2.7.1 PAI III-1. Brewerton & Tolchester Channel Intersection.

The intersection might more properly be called a junction point of three channels at the point where traffic bound to and from Baltimore must make a radical course change. Inbound deep-draft ships must complete the turn lined up for transit through the Brewerton Channel which, although well marked, is only 450 feet wide in its Eastern Extension. Movement management advice may be required to prevent adverse meetings or ones which hamper turning. Navigational assistance may be required, particularly in winter if ice has disturbed aids to navigation.

TABLE 2-1. CHESAPEAKE BAY NORTH/BALTIMORE, MD PROBLEM AREA IDENTIFIERS

SZ	LOCATION	PROBLEM	MANAGEMENT
I	Northern Chesapeake Bay	Data catchment for inbound shipping	Have real-time knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Northern Approaches	Data catchment area for inbound shipping.	Same As Above.
III	Outer Baltimore Harbor	Narrow channels where meetings, overtakings must be managed. The potential for localized congestion. Queuing control may be required. Navigation may be difficult under some conditions.	Have real-time knowledge of vessel movements and locations. Provide movement management advice and manage anchorages.
IV	Baltimore Harbor	Potential for congestion. Outbound queuing may be needed. Anchorage management.	Same As Above.

2.7.2 PAI III-2. North Point Bifurcation

South of North Point the main channels into Baltimore from the east and south join to form the primary Brewerton Channel. Inbound traffic from the south will potentially cross the track of outbound shipping continuing to the east through Brewerton Channel. Movement management advice is required to smoothly and safely manage the traffic flows.

2.7.3 PAI IV-1. Fort McHenry Junction

The channel junction off Fort McHenry is a potentially difficult one, depending upon traffic density. Inbound traffic is screened from ships departing inner Baltimore until both are approaching the junction.

3.0 PORT OF BALTIMORE VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Baltimore is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 1). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The four sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is

essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company, vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Baltimore VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the overall conclusion that one control sector managed by one watchstander is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone I

Tilghman Island Site	1 Module 10 VHF

3.2.2.2 Sub-Zone II

Turkey Point Site	1 Module 10 VHF
	1 Module 11 VHF

3.2.2.3 Sub-Zone III

Radar and comms coverage from Sub-Zone IV.

3.2.2.4 Sub-Zone IV

Hawkins Point Site	1 Module 1 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I										1									
II										1	1								
III																			
IV	1									1	1		1						

FIGURE 3-1. CHESAPEAKE NORTH/BALTIMORE, MD SURVEILLANCE SURVEY

interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Baltimore in a location with good visual surveillance of the Harbor. The center is to employ the following equipment:

3.2.3.1 VTS console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.
- o Software providing the total integration of data from all VTS sensors.
- o Layering of data in at least four layers to be operator selectable.
- o The ability to sector data including sector to sector handoff of targets.
- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.
- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.
- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.
- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Baltimore VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring
VTS Console (1 workstation)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (1 radar site)	100	
Sub-total:	750	300
Sub-Zone I--Northern Chesapeake Bay		
1 Module 10 VHF	19	13
Sub-total:	19	13
Sub-Zone II--Northern Approaches		
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
Sub-total:	67	33
Sub-Zone III--Outer Baltimore Harbor (NOAA Charts 12273 & 12278)		
Required comms/radar coverage from Sub-Zone IV below.		
Sub-Zone IV--Baltimore Harbor (NOAA Chart 12281)		
1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	417	348
HARDWARE TOTALS:	1253	694

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1253
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	627
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no serious problem, one accessible site	125
Spares & Training (10%)	125
Civil Engineering 1 remote radar site, a VTC in Baltimore, several remote comms and WX sensors installations, minor land acquisition	1500
PROJECT ESTIMATE:	3630
Data Base Management System	300
TOTAL: (non-recurring)	$3930

Recurring (10 year)

Hardware	694
1 Watchstander x 5 = 10 man/years @ 50K x 10	5000
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4194
TOTAL 10-YEAR PROJECT COST:	$ 8124

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1. Summary Statistics on Leading Ports, 1987, Center for Marine Conservation, Washington, D.C., 1990.

2. United States Coast Pilot, Atlantic Coast: Sandy Hook to Cape Henry, 27th Edition, 1989, NOAA, Washington, D.C., p. T-10.

3. Ibid, p. 54

4. Ibid, p. 30.

5. Summary Statistics on Leading Ports, 1987, Center for Marine Conservation, Washington, D.C., 1990.

6. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: **Intracoastal Waterway**

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING SURVEILLANCE EQUIPMENT

BALTIMORE (With Additional Radar and Separate VTC)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center

	recurring	non-recurring
VTS Console (2 workstations & software)	750	
Comms console	100	
Recording Equipment	50	
SCADA Equipment	100	
Sub-total:	1000	500

<u>Sub-Zone I--Northern Chesapeake Bay</u>

1 Module 10 VHF	19	13
Sub-total:	19	13

<u>Sub-Zone II--Northern Approaches</u>

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	507	438

<u>Sub-Zone III--Outer Baltimore Harbor (NOAA Charts 12273 & 12278)</u>

Required comms/radar coverage from Sub-Zone IV below.

<u>Sub-Zone IV--Baltimore Harbor (NOAA Chart 12281)</u>

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	417	348
HARDWARE TOTALS:	1943	1299

BALTIMORE (Cont.)

2.0 PROJECT TOTALS (x $1000)

2.1 Non-recurring

Hardware	1943
Management Engineering (50%)	972
Installation (10%)	194
Spares and Training (10%)	194
Civil Engineering 2 radar sites, a VTC in the Baltimore area, remote comms, wx sensor installations, remote access no problem	1500
PROJECT ESTIMATE:	4803
Data Base Management System	300
TOTAL:	5103

2.2 Recurring (10-year)

Hardware	1299
1 Watchstander x 5 = 10 man/years @ 50K x 10	2500
1 Supervisor-day worker	500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL:	5299
TOTAL PROJECT COST:	10402

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I										1									
II			1							1	1		1						
III																			
IV	1									1	1		1						

BALTIMORE, MD SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix I   Zone 9 Chesapeake North/Baltimore, MD

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone	901C	
248	A	INLAND WATERWAY FROM DELAWARE RIVER TO CHESAPEAKE BAY, DEL.
402	A	MIDDLE RIVER AND DARK HEAD CREEK, MD.
418	A	KNAPPS NARROWS, MD.
419	A	TRED AVON RIVER, MD.
423	A	CHOPTANK RIVER, MD.
428	A	HONGA RIVER AND TAR BAY, MD.
431	A	FISHING BAY TRIBUTARIES, DORCHESTER COUNTY, MD.
439	A	UPPER THOROUGHFARE, DEAL ISLAND, MD.
445	A	BROAD CREEK, SOMERSET COUNTY, MD.
448	A	TWITCH COVE AND BIG THOROUGHFARE RIVER, MD.
452	A	POTOMAC RIVER BELOW WASHINGTON, D. C.
463	A	BRETON BAY, MD.
477	A	COAN RIVER, VA.
479	A	PATUXENT RIVER, MD.
483	A	FISHING CREEK, CALVERT COUNTY, MD.
700	A	BALTIMORE HARBOR AND CHANNELS, MD.
700	B	BALTIMORE HARBOR AND CHANNELS, MD.
711	A	CAMBRIDGE HARBOR, MD.
712	A	CRISFIELD HARBOR, MD.
727	A	ANNAPOLIS HARBOR, MD.
Subzone	902D	
700	A	BALTIMORE HARBOR AND CHANNELS, MD.
700	B	BALTIMORE HARBOR AND CHANNELS, MD.
Subzone	903F	
248	A	INLAND WATERWAY FROM DELAWARE RIVER TO CHESAPEAKE BAY, DEL.

Appendix I Zone 9 Chesapeake North/Baltimore, MD 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 901C Northern Chesapeake Bay

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,793,119	0	69,656	0	1,862,775
2	FOREST PRODUCTS	89,491	0	0	0	89,491
3	FISHERIES PRODUCTS	9,580	0	0	0	9,580
4	MINING PRODUCTS, NEC	19,384,591	0	6,509,172	0	25,893,763
5	PROC. FOODS & MFTRS, NEC	16,354,192	0	1,954,254	0	18,308,[illegible]46
6	WASTE OF MANUFACTURING	298,735	0	20,620	0	319,355
1311	CRUDE PETROLEUM	0	0	0	1[illegible],770	12,770
1492	SULPHUR, DRY	4,242	0	158	0	4,400
2810	SODIUM HYDROXIDE (CAUSTI	96,764	0	57,751	0	154,515
2811	CRUDE PROD-COAL TAR-PET	61,242	0	1,839	0	63,081
2813	ALCOHOLS	0	22,188	0	2,190	24,378
2817	BENZENE AND TOLUENE	0	4,132	0	19,650	23,782
2818	SULPHURIC ACID	15,547	17,246	0	187,810	220,603
2871	NITROGEN CHEM FERTILIZER	15,734	135,129	0	38,167	189,030
2872	POTASSIC CHEM FERTILIZER	108,098	0	42	0	108,140
2873	PHOSPHA CHEM FERTILIZERS	3,759	0	28,750	0	32,509
2911	GASOLINE, INCL NATURAL	0	427,309	0	1,823,938	2,251,247
2912	JET FUEL	0	31	0	673,849	673,880
2913	KEROSENE	0	70,843	0	82,326	153,169
2914	DISTILLATE FUEL OIL	0	763,878	0	1,345,246	2,109,124
2915	RESIDUAL FUEL OIL	0	1,031,828	0	3,527,118	4,558,946
2916	LUBRIC OILS-GREASES	0	68,425	0	19,343	87,768
2917	NAPHTHA, PETRLM SOLVENTS	0	44,627	0	13,958	58,585
2921	LIQUI PETR-COAL-NATR GAS	237	760	0	88	1,085
	Subzone Total :	38,235,331	2,586,396	8,642,242	7,746,453	57,210,422

Subzone 902D Baltimore Harbor

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,749,939	0	63,312	0	1,813,251
2	FOREST PRODUCTS	88,017	0	0	0	88,017
3	FISHERIES PRODUCTS	9,580	0	0	0	9,580
4	MINING PRODUCTS, NEC	17,729,916	0	3,174,635	0	20,904,551
5	PROC. FOODS & MFTRS, NEC	8,000,671	0	572,411	0	8,573,082
6	WASTE OF MANUFACTURING	271,246	0	10,212	0	281,458
1492	SULPHUR, DRY	4,242	0	158	0	4,400
2810	SODIUM HYDROXIDE (CAUSTI	5,437	0	28,216	0	33,653
2811	CRUDE PROD-COAL TAR-PET	61,242	0	1,839	0	63,081
2813	ALCOHOLS	0	14,956	0	2,190	17,146
2817	BENZENE AND TOLUENE	0	2,280	0	3,946	6,226
2818	SULPHURIC ACID	15,547	0	0	62,130	77,677
2871	NITROGEN CHEM FERTILIZER	15,734	123,128	0	31,936	170,798
2872	POTASSIC CHEM FERTILIZER	86,905	0	42	0	86,947
2873	PHOSPHA CHEM FERTILIZERS	3,500	0	16,343	0	19,843
2911	GASOLINE, INCL NATURAL	0	240,943	0	896,768	1,137,711
2912	JET FUEL	0	31	0	7,081	7,112
2913	KEROSENE	0	54,191	0	42,207	96,398
2914	DISTILLATE FUEL OIL	0	331,131	0	562,104	893,235
2915	RESIDUAL FUEL OIL	0	767,188	0	2,036,653	2,803,841
2916	LUBRIC OILS-GREASES	0	36,845	0	15,388	52,233
2917	NAPHTHA, PETRLM SOLVENTS	0	37,366	0	9,760	47,[illegible]26
2921	LIQUI PETR-COAL-NATR GAS	237	760	0	88	1,[illegible]85
	Subzone Total :	28,042,213	1,608,819	3,867,168	3,670,251	37,188,451

Appendix I Zone 9 Chesapeake North/Baltimore, MD 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 903F D & C Canal Entrance

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	43,180	0	0	0	43,180
2	FOREST PRODUCTS	1,474	0	0	0	1,474
4	MINING PRODUCTS, NEC	1,654,675	0	1,065,324	0	2,719,999
5	PROC. FOODS & MFTRS, NEC	8,168,390	0	1,171,996	0	9,340,386
6	WASTE OF MANUFACTURING	27,489	0	9,883	0	37,372
1311	CRUDE PETROLEUM	0	0	0	12,770	12,770
2810	SODIUM HYDROXIDE (CAUSTI	91,327	0	29,535	0	120,862
2813	ALCOHOLS	0	7,232	0	0	7,232
2817	BENZENE AND TOLUENE	0	1,852	0	15,704	17,556
2818	SULPHURIC ACID	0	17,246	0	125,680	142,926
2871	NITROGEN CHEM FERTILIZER	0	12,001	0	6,231	18,232
2872	POTASSIC CHEM FERTILIZER	21,193	0	0	0	21,193
2873	PHOSPHA CHEM FERTILIZERS	259	0	7,198	0	7,457
2911	GASOLINE, INCL NATURAL	0	170,611	0	882,336	1,052,947
2912	JET FUEL	0	0	0	269,153	269,153
2913	KEROSENE	0	16,564	0	39,693	56,257
2914	DISTILLATE FUEL OIL	0	114,404	0	339,695	454,099
2915	RESIDUAL FUEL OIL	0	138,524	0	738,154	876,678
2916	LUBRIC OILS-GREASES	0	31,580	0	3,955	35,535
2917	NAPHTHA, PETRLM SOLVENTS	0	7,261	0	4,198	11,459
	Subzone Total :	10,007,987	517,275	2,283,936	2,437,569	15,246,767

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Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 901C				
Passenger	0	20	1,254	1,274
Dry Cargo	947	4,977	24,115	30,039
Tanker	81	394	1,582	2,057
Dry Cargo Barge Tow	391	0	7,406	7,797
Tanker Barge Tow	203	0	7,684	7,887
Tug/Tow Boat	0	0	14,349	14,349
Subzone Total:	1,622	5,391	56,390	63,403
Subzone : 902D				
Passenger	0	20	2,334	2,354
Dry Cargo	804	3,848	12,252	16,904
Tanker	64	276	1,505	1,845
Dry Cargo Barge Tow	338	0	1,943	2,281
Tanker Barge Tow	129	0	4,850	4,979
Tug/Tow Boat	0	0	13,671	13,671
Subzone Total:	1,335	4,1[illegible]	36,555	42,034
Subzone : 903F				
Dry Cargo	143	1,107	614	1,864
Tanker	3	112	65	180
Dry Cargo Barge Tow	53	0	1,709	1,762
Tanker Barge Tow	54	0	2,057	2,111
Tug/Tow Boat	67	0	112	179
Subzone Total:	320	1,219	4,557	6,096

Note: Sum of all vessel transits within each study subzone.

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Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 9 Chesapeake North/Baltimore, MD

Vessel Type	Large	Medium	Small	Total
Passenger	0	20	2,334	2,354
Dry Cargo	947	4,977	24,135	30,059
Tanker	81	394	1,582	2,057
Dry Cargo Barge Tow	391	0	7,406	7,797
Tanker Barge Tow	203	0	7,793	7,996
Tug/Tow Boat	0	0	14,590	14,590
Zone Total:	1,622	5,391	57,840	64,853

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix I Zone 9 Chesapeake North/Baltimore, MD

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix I Zone 9 Chesapeake North/Baltimore, MD

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
901C	Northern Chesapeake Bay	89,565	52.25
902D	Baltimore Harbor	3,339	111.30
903F	D & C Canal Entrance	3,490	268.46
	Total for Zone	96,394	54.86

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 901C				
Passenger	0	21	1,297	1,317
Dry Cargo	1,189	6,351	28,880	36,420
Tanker	95	435	1,723	2,253
Dry Cargo Tow	215	0	8,573	8,788
Tanker Tow	141	0	8,727	8,868
Tug/Tow Boat	0	0	19,518	19,518
Subzone Total:	1,640	6,807	68,718	77,164
Subzone : 902D				
Passenger	0	21	2,413	2,434
Dry Cargo	1,006	4,871	15,547	21,424
Tanker	70	306	1,632	2,008
Dry Cargo Tow	215	0	2,289	2,504
Tanker Tow	141	0	5,432	5,573
Tug/Tow Boat	0	0	17,532	17,532
Subzone Total:	1,432	5,198	44,845	51,475
Subzone : 903F				
Dry Cargo	183	1,453	836	2,472
Tanker	3	122	70	195
Dry Cargo Tow	0	0	1,987	1,987
Tanker Tow	0	0	2,306	2,306
Tug/Tow Boat	0	0	243	243
Subzone Total:	186	1,575	5,442	7,203

Note: Sum of all vessel transits within each study subzone.

Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 901C				
Passenger	0	21	1,341	1,362
Dry Cargo	1,385	7,412	32,263	41,060
Tanker	115	467	1,853	2,435
Dry Cargo Tow	245	0	9,382	9,627
Tanker Tow	150	0	9,369	9,519
Tug/Tow Boat	0	0	22,679	22,679
Subzone Total:	1,895	7,900	76,887	86,682
Subzone : 902D				
Passenger	0	21	2,495	2,517
Dry Cargo	1,167	5,653	18,067	24,887
Tanker	74	329	1,741	2,144
Dry Cargo Tow	245	0	2,537	2,782
Tanker Tow	150	0	5,833	5,983
Tug/Tow Boat	0	0	20,509	20,509
Subzone Total:	1,636	6,003	51,182	58,822
Subzone : 903F				
Dry Cargo	218	1,728	1,016	2,962
Tanker	4	131	75	210
Dry Cargo Tow	0	0	2,184	2,184
Tanker Tow	0	0	2,477	2,477
Tug/Tow Boat	0	0	290	290
Subzone Total:	222	1,859	6,042	8,123

Note: Sum of all vessel transits within each study subzone.

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 901C				
Passenger	0	22	1,380	1,402
Dry Cargo	1,618	8,705	36,225	46,548
Tanker	138	503	1,989	2,630
Dry Cargo Tow	280	0	10,271	10,551
Tanker Tow	161	0	10,056	10,217
Tug/Tow Boat	0	0	26,497	26,497
Subzone Total:	2,197	9,230	86,418	97,845
Subzone : 902D				
Passenger	0	22	2,568	2,590
Dry Cargo	1,358	6,601	21,130	29,089
Tanker	80	354	1,855	2,289
Dry Cargo Tow	280	0	2,813	3,093
Tanker Tow	161	0	6,264	6,425
Tug/Tow Boat	0	0	24,122	24,122
Subzone Total:	1,879	6,977	58,752	67,608
Subzone : 903F				
Dry Cargo	260	2,069	1,241	3,570
Tanker	4	141	80	225
Dry Cargo Tow	0	0	2,401	2,401
Tanker Tow	0	0	2,661	2,661
Tug/Tow Boat	0	0	350	350
Subzone Total:	264	2,210	6,733	9,207

Note: Sum of all vessel transits within each study subzone.

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Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 901C				
Passenger	0	23	1,420	1,443
Dry Cargo	1,900	10,276	40,910	53,086
Tanker	160	541	2,137	2,838
Dry Cargo Tow	321	0	11,244	11,565
Tanker Tow	172	0	10,796	10,968
Tug/Tow Boat	0	0	31,106	31,106
Subzone Total:	2,553	10,840	97,613	111,006
Subzone : 902D				
Passenger	0	23	2,644	2,666
Dry Cargo	1,587	7,745	24,854	34,186
Tanker	85	381	1,981	2,447
Dry Cargo Tow	321	0	3,122	3,443
Tanker Tow	172	0	6,726	6,898
Tug/Tow Boat	0	0	28,502	28,502
Subzone Total:	2,165	8,149	67,829	78,142
Subzone : 903F				
Dry Cargo	313	2,491	1,523	4,327
Tanker	5	152	85	242
Dry Cargo Tow	0	0	2,641	2,641
Tanker Tow	0	0	2,859	2,859
Tug/Tow Boat	0	0	424	424
Subzone Total:	318	2,643	7,532	10,493

Note: Sum of all vessel transits within each study subzone.

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Appendix I ZONE 9 Chesapeake North/Baltimore, MD

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
	1995 FORECASTED ZONE TOTALS			
Passenger	0	21	2,413	2,434
Dry Cargo	1,086	5,794	27,382	34,262
Tanker	95	435	1,723	2,253
Dry Cargo Tow	215	0	8,573	8,788
Tanker Tow	141	0	8,727	8,868
Tug/Tow Boat	0	0	19,518	19,518
1995 Zone Total:	1,537	6,250	68,336	76,123
	2000 FORECASTED ZONE TOTALS			
Passenger	0	21	2,495	2,517
Dry Cargo	1,196	6,392	29,524	37,112
Tanker	115	467	1,853	2,435
Dry Cargo Tow	245	0	9,382	9,627
Tanker Tow	150	0	9,369	9,519
Tug/Tow Boat	0	0	22,679	22,679
2000 Zone Total:	1,706	6,880	75,302	83,889
	2005 FORECASTED ZONE TOTALS			
Passenger	0	22	2,568	2,590
Dry Cargo	1,397	7,290	32,427	41,114
Tanker	138	503	1,989	2,630
Dry Cargo Tow	280	0	10,271	10,551
Tanker Tow	161	0	10,056	10,217
Tug/Tow Boat	0	0	26,497	26,497
2005 Zone Total:	1,976	7,815	83,808	93,599
	2010 FORECASTED ZONE TOTALS			
Passenger	0	23	2,644	2,666
Dry Cargo	1,641	8,606	36,434	46,681
Tanker	160	541	2,137	2,838
Dry Cargo Tow	321	0	11,244	11,565
Tanker Tow	172	0	10,796	10,968
Tug/Tow Boat	0	0	31,106	31,106
2010 Zone Total:	2,294	9,170	94,361	105,824

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix I Zone 9 Chesapeake North/Baltimore, MD 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 901C Northern Chesapeake Bay						
Dry Cargo	Large	2	0	4	0	6
Dry Cargo	Medium	0	0	3	0	3
Dry Cargo	Small	1	0	1	0	2
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Large	1	0	0	0	1
Dry Cargo Barge Tow	Small	2	2	6	0	10
Tanker Barge Tow	Small	1	0	3	0	4
Fishing	Small	0	0	0	5	5
Other	Small	1	2	0	0	3
Subzone Totals:		8	4	18	5	35
Subzone: 902D Baltimore Harbor						
Passenger	Small	0	0	1	0	1
Dry Cargo	Large	0	1	1	0	2
Dry Cargo Barge Tow	Small	0	0	0	1	1
Subzone Totals:		0	1	2	1	4
Subzone: 903F D & C Canal Entrance						
Dry Cargo	Large	1	0	2	0	3
Dry Cargo	Medium	1	0	0	0	1
Dry Cargo Barge Tow	Small	0	0	1	0	1
Subzone Totals:		2	0	3	0	5
Zone Totals:		10	5	23	6	44

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE I-8 ZONE 9, CHESAPEAKE NORTH/BALTIMORE, MD - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
0901C																	I
0902D																	III
0903F	I	I	I	I	I	I	I	I	I	I	I	I					III

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

NOTE ALL VESSELS WITH DRAFT GREATER THAN 18 FEET, AND 60% OF BARGES PARTICIPATE 1979 THROUGH PRESENT.

APPENDIX TABLE I-9 ZONE 9, CHESAPEAKE NORTH/BALTIMORE, MD
CANDIDATE VTS DESIGN - 1995-2010

<u>UNITS</u>

1	<u>Radar Module 1</u> - Average Performance
0	<u>Radar Module 2</u> - Average Performance
1	<u>Radar Module 3</u> - High Performance
0	<u>Radar Module 4</u> - High Performance
0	<u>Radar Module 5</u> - Special Purpose
0	<u>Radar Module 6</u> - Special Purpose
0	<u>ADS Module 7</u> - Active Radar Transponder (Type 1)
0	<u>ADS Module 8</u> - Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	<u>ADS Module 9</u> - Positional Transponder, Small Area, High Accuracy (Type 6)
3	<u>VHF Module 10</u> - Low power VHF Transmitting/ Receiving Facility
2	<u>VHF Module 11</u> - High power VHF Transmitting/ Receiving Facility
0	<u>Meteorological Module 12</u> - Air temperature, wind direction and speed
2	<u>Meteorological Module 13</u> - Air temperature, wind direction and speed, visibility
0	<u>Hydrological Module 14</u> - Water Temperature and Depth
0	<u>Hydrological Module 15</u> - Water Temperature, Depth and Current
0	<u>VHF/DF MODULE 16</u> - Line of position measurement to 2 degree RMS
0	<u>CCTV MODULE 17</u> - Fixed Focus CCTV via Telephone Lines
0	<u>CCTV MODULE 18</u> - Remotely Controllable CCTV via

Appendix I   Zone 9 Chesapeake North/Baltimore, MD

TABLE 10A   Avoided Vessel Casualties 1996 - 2010   7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.02	.00	.02	.04
Dry Cargo	Large	.28	.09	.40	.77
Dry Cargo	Medium	.67	.19	.29	1.14
Dry Cargo	Small	.44	.11	.10	.65
Tanker	Large	.03	.02	.05	.09
Tanker	Medium	.03	.00	.02	.05
Tanker	Small	.04	0.00	.04	.07
Dry Cargo Barge T	Large	.21	0.00	.25	.46
Dry Cargo Barge T	Small	1.14	.49	.45	2.08
Tanker Barge Tow	Large	.02	.02	.01	.05
Tanker Barge Tow	Small	1.76	.51	1.29	3.57
Tug/Tow Boat	Small	.35	.28	.35	.98
		4.99	1.72	3.28	9.98

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	13	0	12	25
Passenger	Small	15	4	12	31
Dry Cargo	Large	370	178	127	675
Dry Cargo	Medium	1,043	379	88	1,511
Dry Cargo	Small	302	81	62	444
Tanker	Large	114	84	73	271
Tanker	Medium	46	8	10	64
Tanker	Small	18	0	9	27
Dry Cargo Barge T	Large	25	0	5	30
Dry Cargo Barge T	Small	61	47	7	115
Tanker Barge Tow	Large	95	119	56	269
Tanker Barge Tow	Small	9,386	2,223	1,052	12,662
Tug/Tow Boat	Small	27	49	25	101
		11,515	3,172	1,539	16,226

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix I   Zone 9 Chesapeake North/Baltimore, MD

TABLE 10B   Avoided Vessel Casualties 1996 - 2010   7/31/91
Existing VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Dry Cargo	Large	.06	.02	.06	.13
Dry Cargo	Medium	.18	.05	.06	.29
Dry Cargo	Small	.03	.01	.00	.04
Tanker	Large	.00	.00	.00	.01
Tanker	Medium	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	.35	.20	.08	.63
Tanker Barge Tow	Small	.42	.14	.17	.73
Tug/Tow Boat	Small	.01	.00	.00	.01
		1.06	.42	.38	1.86

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Dry Cargo	Large	79	25	19	122
Dry Cargo	Medium	286	87	18	391
Dry Cargo	Small	20	4	2	25
Tanker	Large	9	3	6	18
Tanker	Medium	12	2	2	16
Tanker	Small	1	0	0	1
Dry Cargo Barge T	Small	19	7	1	27
Tanker Barge Tow	Small	2,197	767	175	3,139
Tug/Tow Boat	Small	0	0	0	1
		2,624	895	222	3,741

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.03	.01	.05	.09
Dry Cargo	Medium	.08	.02	.04	.14
Dry Cargo	Small	.03	.01	.01	.04
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.15	.05	.10	.30
Candidate VTS Design - Dollars					
Passenger	Medium	1,382.94	0.00	2,008.27	3,391.21
Passenger	Small	1,612.78	468.15	1,906.69	3,987.62
Dry Cargo	Large	50,446.86	17,413.13	73,764.26	141,624.24
Dry Cargo	Medium	125,723.32	35,528.43	54,084.20	215,335.94
Dry Cargo	Small	41,993.25	10,599.57	9,587.79	62,180.60
Tanker	Small	117.27	0.00	122.07	239.34
Dry Cargo Barge Tow	Small	3,663.46	1,570.81	1,471.66	6,705.93
Tanker Barge Tow	Small	5,833.10	1,691.38	4,277.36	11,801.84
Tug/Tow Boat	Small	1,145.36	928.18	1,152.79	3,226.32
Totals		231,918.34	68,199.63	148,375.08	448,493.05
Existing VTS Design - Counts					
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.02	.01	.01	.04
Dry Cargo	Small	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.03	.01	.02	.06
Existing VTS Design - Dollars					
Dry Cargo	Large	10,279.31	2,814.53	10,910.95	24,004.79
Dry Cargo	Medium	34,737.39	9,009.26	10,850.49	54,597.14
Dry Cargo	Small	2,765.82	599.60	286.12	3,651.53
Tanker	Small	5.98	0.00	2.78	8.75
Dry Cargo Barge Tow	Small	1,150.04	663.80	272.73	2,086.57
Tanker Barge Tow	Small	1,384.94	461.35	551.76	2,398.05
Tug/Tow Boat	Small	21.28	13.77	9.24	44.29
Totals		50,344.76	13,562.30	22,884.06	86,791.12

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.01	.00	.02	.03
Dry Cargo	Large	.00	.00	.01	.01
Dry Cargo	Medium	.01	.00	.00	.02
Dry Cargo	Small	.33	.08	.08	.49
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.01	.05
Tanker Barge Tow	Small	.04	.01	.03	.09
Tug/Tow Boat	Small	.01	.01	.01	.02
Totals		.44	.12	.15	.71
Candidate VTS Design - Dollars					
Passenger	Medium	23.74	0.00	34.48	58.23
Passenger	Small	3,036.89	881.54	3,590.32	7,508.76
Dry Cargo	Large	836.10	293.50	1,279.65	2,409.25
Dry Cargo	Medium	2,158.64	610.01	928.61	3,697.26
Dry Cargo	Small	79,073.99	19,959.16	18,053.96	117,087.11
Tanker	Small	204.91	0.00	213.29	418.20
Dry Cargo Barge Tow	Small	6,511.30	2,744.70	2,592.52	11,848.51
Tanker Barge Tow	Small	10,192.26	2,955.37	7,473.89	20,621.52
Tug/Tow Boat	Small	2,001.30	1,621.81	2,014.29	5,637.40
Totals		104,039.12	29,066.10	36,181.02	169,286.24
Existing VTS Design - Counts					
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.02	.00	.00	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.02
Tanker Barge Tow	Small	.01	.00	.00	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.04	.01	.01	.07
Existing VTS Design - Dollars					
Dry Cargo	Large	176.49	47.04	187.34	410.87
Dry Cargo	Medium	596.43	154.69	186.30	937.42
Dry Cargo	Small	5,208.08	1,129.05	538.76	6,875.89
Tanker	Small	10.45	0.00	4.85	15.30
Dry Cargo Barge Tow	Small	2,009.48	1,159.86	476.54	3,645.88
Tanker Barge Tow	Small	2,419.93	806.12	964.10	4,190.15
Tug/Tow Boat	Small	37.18	24.06	16.15	77.39
Totals		10,458.04	3,320.82	2,374.04	16,152.91

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.00	.01
Passenger	Small	.01	.00	.01	.02
Dry Cargo	Large	.19	.07	.04	.29
Dry Cargo	Medium	.50	.13	.03	.66
Dry Cargo	Small	.37	.08	.05	.50
Tanker	Large	.02	.01	.01	.04
Tanker	Medium	.02	.00	.00	.03
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Large	.19	0.00	.05	.24
Dry Cargo Barge Tow	Small	.85	.20	.06	1.12
Tanker Barge Tow	Large	.01	.01	.00	.03
Tanker Barge Tow	Small	1.35	.22	.18	1.74
Tug/Tow Boat	Small	.06	.03	.04	.14
Totals		3.60	.75	.48	4.84
Candidate VTS Design - Dollars					
Passenger	Medium	4,757.66	0.00	4,011.62	8,769.28
Passenger	Small	4,879.27	1,107.03	3,196.26	9,182.57
Dry Cargo	Large	138,464.33	47,971.17	22,530.84	208,966.33
Dry Cargo	Medium	441,468.24	119,390.56	12,452.24	573,311.05
Dry Cargo	Small	71,144.62	14,602.02	13,427.58	99,174.23
Tanker	Large	16,322.69	9,591.32	13,480.40	39,394.40
Tanker	Medium	15,075.23	2,490.64	4,580.22	22,146.10
Tanker	Small	2,324.08	0.00	3,155.50	5,479.58
Dry Cargo Barge Tow	Large	25,075.03	0.00	5,026.90	30,101.94
Dry Cargo Barge Tow	Small	49,722.23	11,642.41	3,156.30	64,520.95
Tanker Barge Tow	Large	2,235.94	1,582.68	537.49	4,356.11
Tanker Barge Tow	Small	95,511.41	15,335.18	16,261.34	127,107.92
Tug/Tow Boat	Small	4,370.16	2,274.67	4,277.05	10,921.88
Totals		871,350.89	225,987.68	106,093.75	1,203,432.32
Existing VTS Design - Counts					
Dry Cargo	Large	.04	.01	.01	.06
Dry Cargo	Medium	.14	.03	.01	.18
Dry Cargo	Small	.02	.00	.00	.03
Tanker	Large	.00	.00	.00	.00
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.27	.08	.01	.36
Tanker Barge Tow	Small	.32	.06	.02	.40
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.80	.19	.05	1.04
Existing VTS Design - Dollars					
Dry Cargo	Large	29,877.42	7,157.02	3,360.03	40,394.47
Dry Cargo	Medium	121,977.82	30,274.92	2,498.19	154,750.93
Dry Cargo	Small	4,685.82	826.01	400.70	5,912.54
Tanker	Large	1,090.41	418.55	675.68	2,184.65
Tanker	Medium	4,636.62	744.32	1,049.89	6,430.83
Tanker	Small	118.48	0.00	71.76	190.23
Dry Cargo Barge Tow	Small	15,413.41	4,926.23	583.61	20,923.25
Tanker Barge Tow	Small	22,677.10	4,182.88	2,077.26	28,937.25
Tug/Tow Boat	Small	81.20	33.74	34.30	149.23
Totals		200,558.27	48,563.67	10,751.44	259,873.38

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.00	.00	.00	.01
Dry Cargo	Large	.07	.03	.04	.14
Dry Cargo	Medium	.18	.07	.03	.27
Dry Cargo	Small	.14	.03	.02	.19
Tanker	Large	.01	.00	.00	.02
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.01	0.00	.00	.01
Dry Cargo Tow	Large	.02	0.00	.02	.03
Dry Cargo Tow	Small	.16	.07	.03	.25
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.25	.07	.07	.39
Tug/Tow Boat	Small	.02	.02	.01	.05
Totals		.86	.29	.23	1.38
Candidate VTS Design - Dollars					
Passenger	Medium	20.93	0.00	12.49	33.42
Passenger	Small	12.34	2.80	7.22	22.36
Dry Cargo	Large	712.89	369.18	105.98	1,188.05
Dry Cargo	Medium	1,881.39	753.25	76.53	2,711.17
Dry Cargo	Small	322.87	66.27	60.28	449.42
Tanker	Large	189.65	159.54	287.30	636.49
Tanker	Medium	107.62	17.77	20.79	146.18
Tanker	Small	17.74	0.00	16.15	33.89
Tanker Tow	Small	18,687.56	6,157.16	6,030.25	30,874.97
Tug/Tow Boat	Small	52.61	27.38	50.11	130.10
Totals		22,005.59	7,553.35	6,667.09	36,226.04
Existing VTS Design - Counts					
Dry Cargo	Large	.01	.01	.01	.02
Dry Cargo	Medium	.05	.02	.01	.07
Dry Cargo	Small	.01	.00	.00	.01
Tanker	Large	.00	.00	.00	.00
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.05	.03	.00	.08
Tanker Tow	Small	.06	.02	.01	.09
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.18	.07	.03	.28
Existing VTS Design - Dollars					
Dry Cargo	Large	167.99	65.17	15.44	248.59
Dry Cargo	Medium	519.83	191.01	15.35	726.19
Dry Cargo	Small	21.27	3.75	1.80	26.81
Tanker	Large	21.05	8.01	16.08	45.13
Tanker	Medium	36.38	5.75	6.08	48.21
Tanker	Small	1.62	0.00	.46	2.08
Tanker Tow	Small	6,557.43	2,184.39	1,063.92	9,805.73
Tug/Tow Boat	Small	.98	.41	.40	1.79
Totals		7,326.53	2,458.47	1,119.53	10,904.53

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix I Zone 9 Chesapeake North/Baltimore, MD 7/26/91

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.01	.00	.01
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.05	.00	.06
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.06	.01	.07
Tug/Tow Boat	Small	0.00	.03	.00	.03
Totals		0.00	.19	.02	.21
Candidate VTS Design - Dollars					
Passenger	Small	0.00	3.15	.64	3.79
Dry Cargo	Large	0.00	59.76	12.80	72.55
Dry Cargo	Medium	0.00	121.92	9.29	131.22
Dry Cargo	Small	0.00	71.26	3.23	74.49
Tanker	Large	0.00	9.88	1.50	11.38
Tanker	Medium	0.00	2.98	.63	3.61
Tanker	Small	0.00	0.00	1.19	1.19
Dry Cargo Barge Tow	Large	0.00	0.00	8.03	8.03
Dry Cargo Barge Tow	Small	0.00	306.58	14.51	321.08
Tanker Barge Tow	Large	0.00	12.54	.44	12.98
Tanker Barge Tow	Small	0.00	330.30	41.82	372.12
Tug/Tow Boat	Small	0.00	181.26	11.27	192.53
Totals		0.00	1,099.63	105.34	1,204.97
Existing VTS Design - Counts					
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.02	.00	.02
Tanker Barge Tow	Small	0.00	.02	.00	.02
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.05	.00	.05
Existing VTS Design - Dollars					
Dry Cargo	Large	0.00	9.66	1.87	11.53
Dry Cargo	Medium	0.00	30.92	1.86	32.78
Dry Cargo	Small	0.00	4.03	.10	4.13
Tanker	Large	0.00	.45	.08	.53
Tanker	Medium	0.00	.91	.14	1.05
Tanker	Small	0.00	0.00	.03	.03
Dry Cargo Barge Tow	Small	0.00	129.63	2.67	132.30
Tanker Barge Tow	Small	0.00	90.09	5.39	95.49
Tug/Tow Boat	Small	0.00	2.69	.09	2.78
Totals		0.00	268.38	12.23	280.61

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.02	0.00	.02
Dry Cargo	Small	.00	.01	0.00	.01
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.02	0.00	.02
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.02	0.00	.02
Tug/Tow Boat	Small	.00	.02	0.00	.02
Totals		.00	.09	0.00	.09
Candidate VTS Design - Dollars					
Passenger	Small	46.73	609.91	0.00	656.64
Dry Cargo	Large	0.00	18,086.06	0.00	18,086.06
Dry Cargo	Medium	0.00	32,764.42	0.00	32,764.42
Dry Cargo	Small	1,026.68	12,881.55	0.00	13,908.24
Tanker	Large	0.00	3,417.62	0.00	3,417.62
Tanker	Medium	0.00	765.04	0.00	765.04
Tanker	Small	86.77	0.00	0.00	86.77
Dry Cargo Barge Tow	Small	884.24	30,908.85	0.00	31,793.08
Tanker Barge Tow	Large	0.00	4,550.24	0.00	4,550.24
Tanker Barge Tow	Small	2,145.09	43,274.44	0.00	45,419.53
Tug/Tow Boat	Small	911.96	34,149.25	0.00	35,061.20
Totals		5,101.46	181,407.38	0.00	186,508.84

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix I Zone 9 Chesapeake North/Baltimore, MD
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	.00	.00	.00	.00	.00
ALCOHOLS	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	0.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.01	.02	.00	.03
DISTILLATE FUEL OIL	.00	.01	.03	.15	.20
GASOLINE, INCL NATURAL	.00	.03	.07	.00	.10
RESIDUAL FUEL OIL	.00	.04	.17	.20	.41
	.01	.08	.30	.35	.74
Existing Vts Design - Counts					
ALCOHOLS	0.00	.00	.00	.00	.00
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	0.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	0.00	.01
DISTILLATE FUEL OIL	.00	.00	.01	.01	.01
RESIDUAL FUEL OIL	.00	.00	.03	.05	.08
GASOLINE, INCL NATURAL	.00	.01	.01	.00	.02
	.00	.01	.06	.05	.13

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix I Zone 9 Chesapeake North/Baltimore, MD
TABLE 18A Annual Benefit & Cost Streams 7/31, [illegible]1
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,103	0	0
1996	0	417	755
1997	0	379	697
1998	0	345	649
1999	0	313	599
2000	0	285	553
2001	0	259	511
2002	0	235	472
2003	0	214	437
2004	0	195	404
2005	0	177	371
2006	0	161	344
2007	0	146	316
2008	0	133	295
2009	0	121	272
2010	0	110	250
	5,103	3,490	6,924

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,103	0	0
1996	0	530	959
1997	0	530	974
1998	0	530	998
1999	0	530	1,013
2000	0	530	1,028
2001	0	530	1,045
2002	0	530	1,063
2003	0	530	1,081
2004	0	530	1,099
2005	0	530	1,113
2006	0	530	1,135
2007	0	530	1,144
2008	0	530	1,177
2009	0	530	1,193
2010	0	530	1,205
	5,103	7,948	16,226

Appendix I
TABLE 18B

Zone 9 Chesapeake North/Baltimore, MD
Annual Benefit & Cost Streams
Existing VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	29
1997	0	0	162
1998	0	0	189
1999	0	0	169
2000	0	0	22
2001	0	0	47
2002	0	0	137
2003	0	0	49
2004	0	0	117
2005	0	0	108
2006	0	0	100
2007	0	0	92
2008	0	0	85
2009	0	0	79
2010	0	0	71
	0	0	1,456

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	37
1997	0	0	227
1998	0	0	291
1999	0	0	285
2000	0	0	40
2001	0	0	95
2002	0	0	309
2003	0	0	121
2004	0	0	319
2005	0	0	324
2006	0	0	330
2007	0	0	334
2008	0	0	340
2009	0	0	346
2010	0	0	343
	0	0	3,741

APPENDIX I

ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Balitmore Port & Subzone	Species Category	(Port 9) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0901	101	1	American Shad	.3528	.3528	0.0000	0.0000
0901	101	2	Alewife	.5311	.5311	0.0000	0.0000
0901	101	31	Hickory Shad	.0011	.0011	.0011	.0011
0901	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0901	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0901	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0901	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0901	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0901	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0901	102	34	Harvestfish	.0010	.0010	.0010	.0010
0901	103	9	Striped Bass	.0567	.0567	.0567	.0567
0901	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0901	105	17	Summer Flounder	.0270	.0270	.0270	.0270
0901	105	18	Atlantic Plaice	.0170	.0090	.0090	.0100
0901	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0901	106	24	Silver Hake	.0010	.0010	.0010	.0010
0901	106	25	Red Hake	.0040	.0020	.0030	.0030
0901	106	26	White Hake	.0090	.0140	.0050	0.0000
0901	106	28	Tilefish	.0330	.0330	.0330	.0330
0901	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0901	106	36	Black Drum	.0059	.0059	.0059	.0059
0901	106	37	Spot	.1182	.1182	.1182	0.0000
0901	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0901	106	39	Carp	.0250	.0250	.0250	.0250
0901	106	48	Catfish	.1647	.1647	.1647	.1647
0901	106	123	White Perch	.0682	.0682	.0682	.0682
0901	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0901	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0901	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0901	107	213	Hard Clam	.0800	.0800	.0800	.0800
0901	107	214	Conch	.0660	.0660	.0660	.0660
0901	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0901	108	206	Red Crab	.2300	.2300	.2300	.2300
0901	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0902	101	1	American Shad	.3528	.3528	0.0000	0.0000
0902	101	2	Alewife	.5311	.5311	0.0000	0.0000
0902	101	31	Hickory Shad	.0011	.0011	.0011	.0011
0902	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0902	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0902	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0902	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0902	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0902	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0902	102	34	Harvestfish	.0010	.0010	.0010	.0010
0902	103	9	Striped Bass	.0567	.0567	.0567	.0567
0902	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0902	105	17	Summer Flounder	.0270	.0270	.0270	.0270
0902	105	18	Atlantic Plaice	.0170	.0090	.0090	.0100
0902	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0902	106	24	Silver Hake	.0010	.0010	.0010	.0010
0902	106	25	Red Hake	.0040	.0020	.0030	.0030
0902	106	26	White Hake	.0090	.0140	.0050	0.0000
0902	106	28	Tilefish	.0330	.0330	.0330	.0330

ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Balitmore Port & Subzone	Species Category	(Port 9) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0902	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0902	106	36	Black Drum	.0059	.0059	.0059	.0059
0902	106	37	Spot	.1182	.1182	.1182	0.0000
0902	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0902	106	39	Carp	.0250	.0250	.0250	.0250
0902	106	48	Catfish	.1647	.1647	.1647	.1647
0902	106	123	White Perch	.0682	.0682	.0682	.0682
0902	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0902	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0902	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0902	107	213	Hard Clam	.0800	.0800	.0800	.0800
0902	107	214	Conch	.0660	.0660	.0660	.0660
0902	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0902	108	206	Red Crab	.2300	.2300	.2300	.2300
0902	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150
0903	101	1	American Shad	.3528	.3528	0.0000	0.0000
0903	101	2	Alewife	.5311	.5311	0.0000	0.0000
0903	101	31	Hickory Shad	.0011	.0011	.0011	.0011
0903	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
0903	102	3	Atl.Menhaden	2.5975	2.5975	0.0000	0.0000
0903	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
0903	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
0903	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
0903	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
0903	102	34	Harvestfish	.0010	.0010	.0010	.0010
0903	103	9	Striped Bass	.0567	.0567	.0567	.0567
0903	103	11	Weakfish	3.0922	3.0922	3.0922	3.0922
0903	105	17	Summer Flounder	.0270	.0270	.0270	.0270
0903	105	18	Atlantic Plaice	.0170	.0090	.0090	.0100
0903	105	20	Winter Flounder	.0140	.0140	.0140	.0140
0903	106	24	Silver Hake	.0010	.0010	.0010	.0010
0903	106	25	Red Hake	.0040	.0020	.0030	.0030
0903	106	26	White Hake	.0090	.0140	.0050	0.0000
0903	106	28	Tilefish	.0330	.0330	.0330	.0330
0903	106	35	Atlantic Croaker	.0841	.0841	.0841	0.0000
0903	106	36	Black Drum	.0059	.0059	.0059	.0059
0903	106	37	Spot	.1182	.1182	.1182	0.0000
0903	106	38	Yellow Perch	.0031	.0031	.0031	.0031
0903	106	39	Carp	.0250	.0250	.0250	.0250
0903	106	48	Catfish	.1647	.1647	.1647	.1647
0903	106	123	White Perch	.0682	.0682	.0682	.0682
0903	107	208	Blue Mussel	761.0000	761.0000	761.0000	761.0000
0903	107	211	Soft Shell Clam	.1362	.1362	.1362	.1362
0903	107	212	American Oyster	1.5740	1.5740	1.5740	1.5740
0903	107	213	Hard Clam	.0800	.0800	.0800	.0800
0903	107	214	Conch	.0660	.0660	.0660	.0660
0903	108	8	Bluefish	0.0000	.3398	.3398	0.0000
0903	108	206	Red Crab	.2300	.2300	.2300	.2300
0903	108	209	Blue Crab	2.0150	2.0150	2.0150	2.0150

APPENDIX I

ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Baltimore Port & Subzone	Species Category	(Port 9) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0901	1	1002	Alosids	.0980	0.0000	0.0000	0.0000
0901	1	1125	Gizzard Shad	0.0000	.2084	0.0000	0.0000
0901	2	1004	Clopeidae	.0806	0.0000	0.0000	0.0000
0901	2	1043	Bay Anchovy	0.0000	.0490	0.0000	0.0000
0901	2	1126	Sunfish	0.0000	.2483	0.0000	0.0000
0901	2	1127	Silversides	0.0000	.4093	0.0000	0.0000
0901	3	1009	Striped Bass	6.5800	0.0000	0.0000	0.0000
0901	6	1038	Yellow Perch	.0050	0.0000	0.0000	0.0000
0901	6	1039	Carp	.0050	0.0000	0.0000	0.0000
0901	6	1123	White Perch	.4612	0.0000	0.0000	0.0000
0902	1	1002	Alosids	.0980	0.0000	0.0000	0.0000
0902	1	1125	Gizzard Shad	0.0000	.2084	0.0000	0.0000
0902	2	1004	Clopeidae	.0806	0.0000	0.0000	0.0000
0902	2	1043	Bay Anchovy	0.0000	.0490	0.0000	0.0000
0902	2	1126	Sunfish	0.0000	.2483	0.0000	0.0000
0902	2	1127	Silversides	0.0000	.4093	0.0000	0.0000
0902	6	1038	Yellow Perch	.0050	0.0000	0.0000	0.0000
0902	6	1039	Carp	.0050	0.0000	0.0000	0.0000
0902	6	1123	White Perch	.4612	0.0000	0.0000	0.0000
0903	1	1002	Alosids	.0980	0.0000	0.0000	0.0000
0903	1	1125	Gizzard Shad	0.0000	.2084	0.0000	0.0000
0903	2	1004	Clopeidae	.0806	0.0000	0.0000	0.0000
0903	2	1043	Bay Anchovy	0.0000	.0490	0.0000	0.0000
0903	2	1126	Sunfish	0.0000	.2483	0.0000	0.0000
0903	2	1127	Silversides	0.0000	.4093	0.0000	0.0000
0903	6	1038	Yellow Perch	.0050	0.0000	0.0000	0.0000
0903	6	1039	Carp	.0050	0.0000	0.0000	0.0000
0903	6	1123	White Perch	.4612	0.0000	0.0000	0.0000

APPENDIX I

ZONE 9 - CHESAPEAKE NORTH/BALTIMORE, MD (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Balitmore Port & Subzone	Species Category	(Port 9) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
0901	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0901	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0901	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0901	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0901	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0901	13		Seabirds	20.3000	7.6000	8.1000	9.9000
0901	14	581	Osprey	.1930	.1930	.1930	.1930
0902	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0902	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0902	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0902	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0902	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0902	13		Seabirds	20.3000	7.6000	8.1000	9.9000
0902	14	581	Osprey	.1930	.1930	.1930	.1930
0903	11	511	Dabbling Ducks	11.6910	11.6910	11.6910	11.6910
0903	11	513	Geese	62.4488	62.4488	62.4488	62.4488
0903	11	514	Swans (Tundra Swan)	3.3469	3.3469	3.3469	3.3469
0903	11	515	Diving Ducks	12.0577	12.0577	12.0577	12.0577
0903	12		Shorebirds	376.6000	144.6000	94.8000	11.7000
0903	13		Seabirds	20.3000	7.6000	8.1000	9.9000
0903	14	581	Osprey	.1930	.1930	.1930	.1930

APPENDIX J

CORPUS CHRISTI, TX

(ZONE 10)

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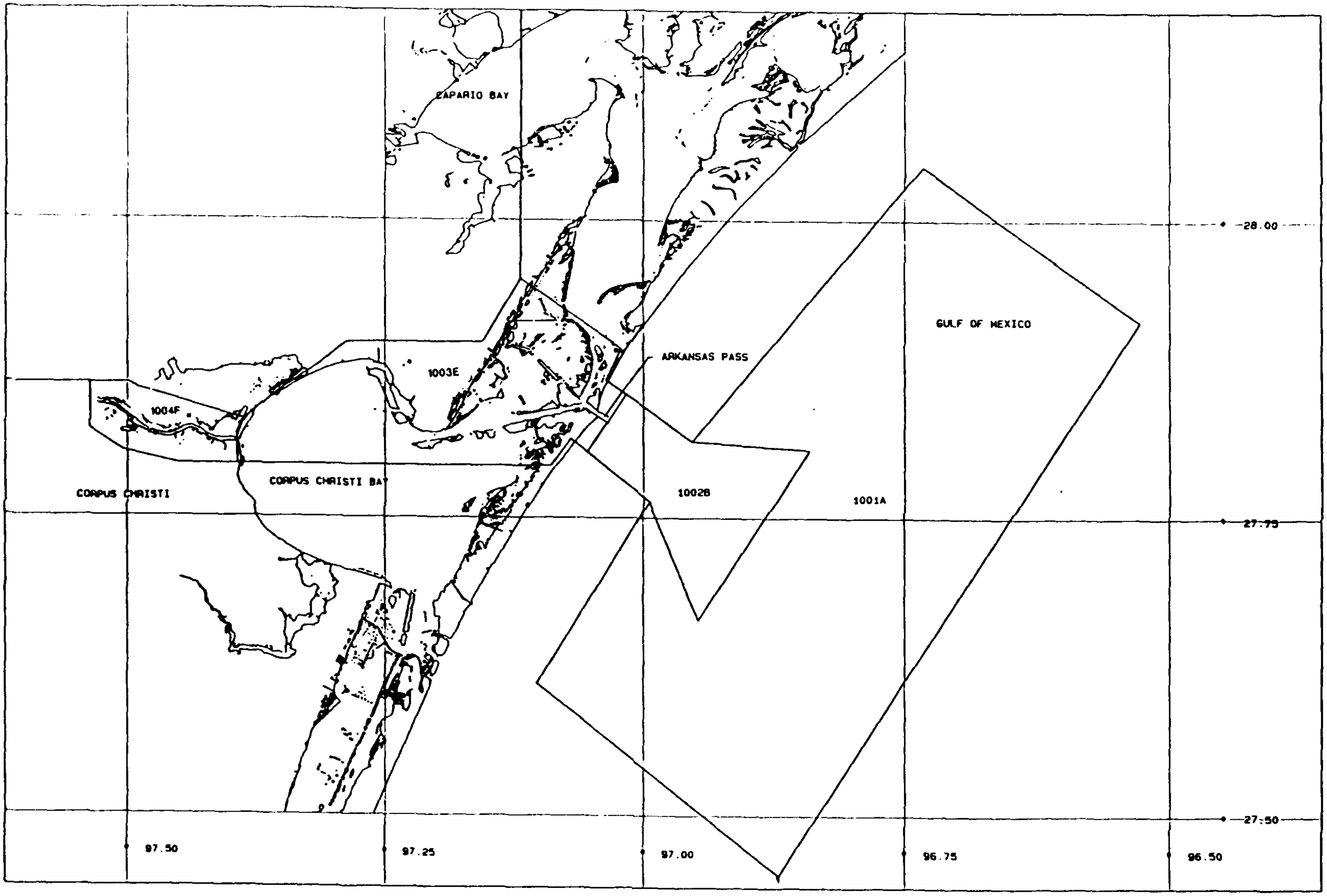
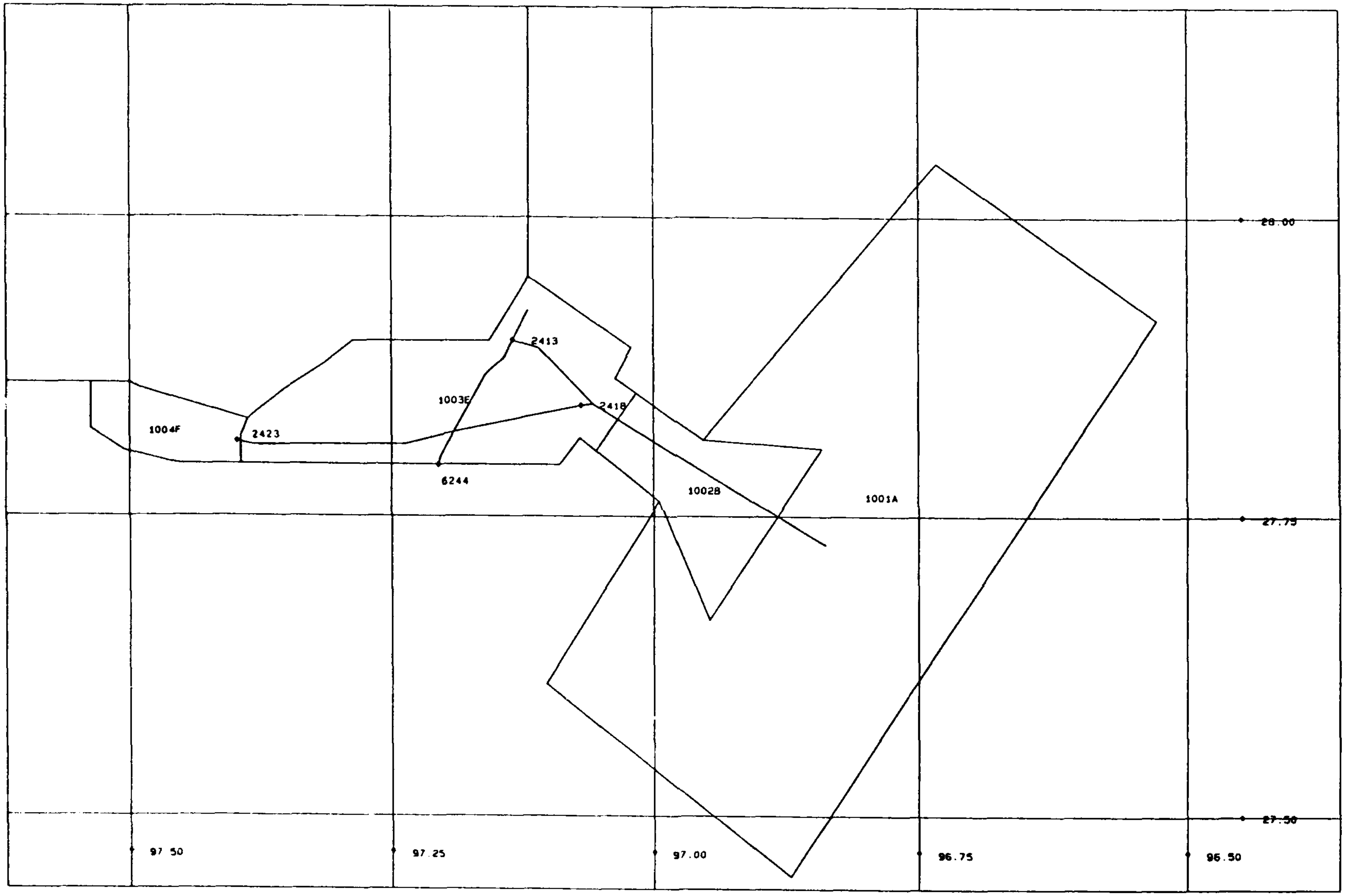
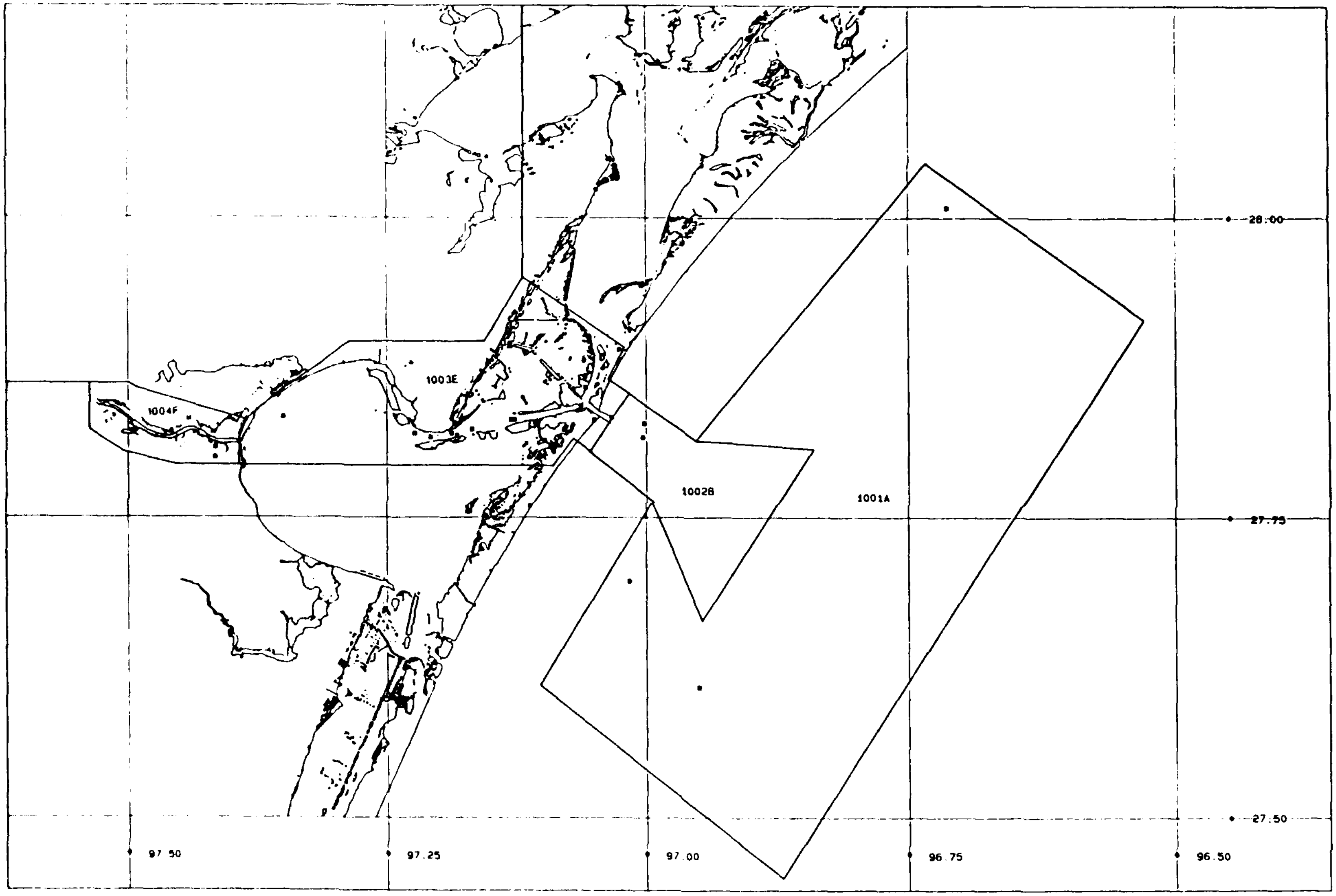
STUDY ZONE MAPS



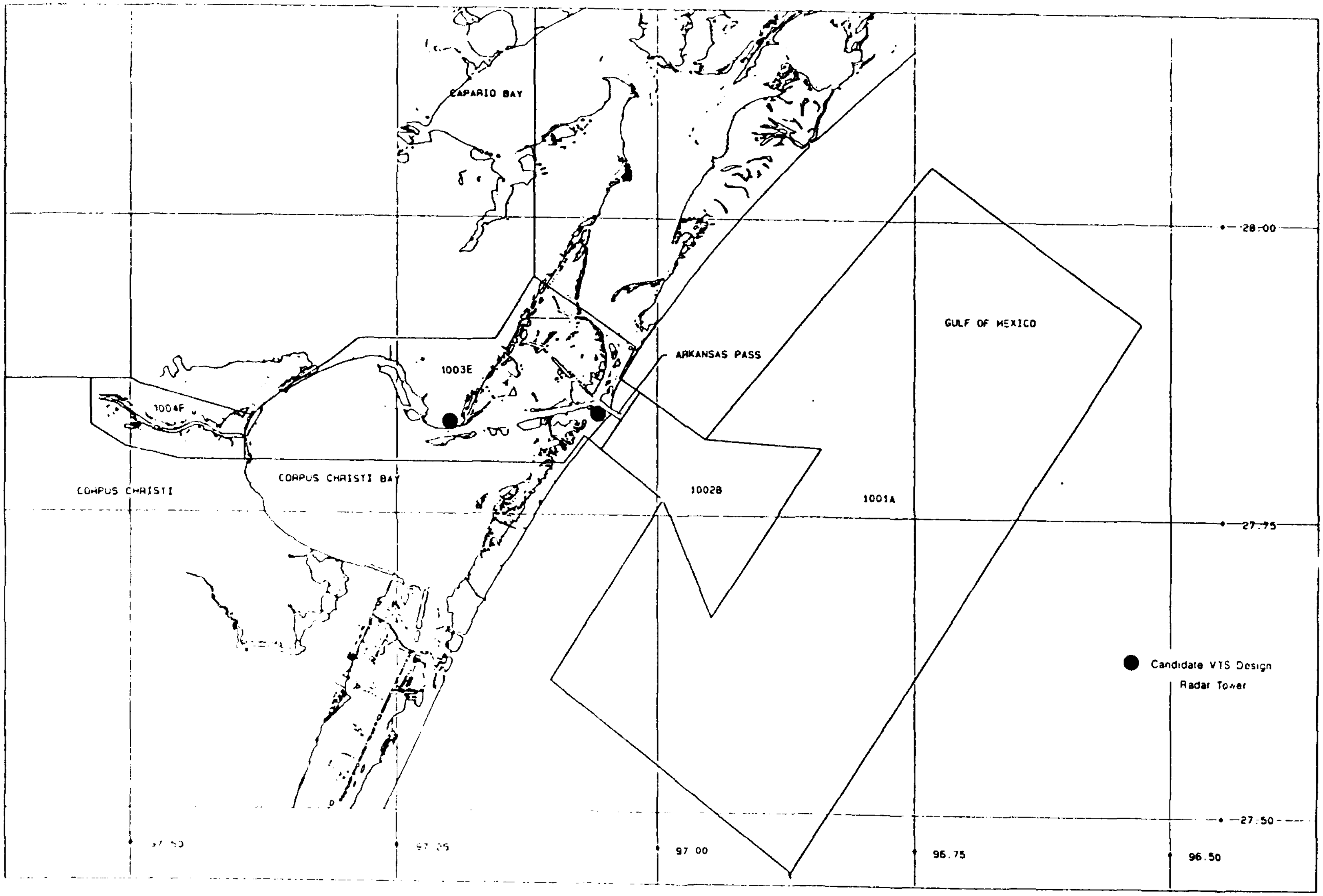
ZONE 10 - CORPUS CHRISTI, TX - ZONE AND SUBZONE BOUNDARIES



ZONE 10 - CORPUS CHRISTI, TX - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 10 - CORPUS CHRISTI, TX - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 10 - CORPUS CHRISTI, TX - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

CORPUS CHRISTI, TX

(ZONE 10)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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CORPUS CHRISTI VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Corpus Christi, Texas. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 CORPUS CHRISTI PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the port and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The port limits used in the study coincide with those of the Port of Corpus Christi Authority and include all of Nueces County, Texas. This encompasses Corpus Christi Main Harbor and facilities along the industrial canal, Tule Lake Channel and Viola Channel. Also falling within the port area are the turning basins from Corpus Christi Turning Basin to Viola Turning Basin, Harbor Island, Port Aransas, Port Ingleside and La Quinta.

The port complex serves both deep-water and coastal traffic, including Intracoastal Waterway (ICW) barges. Better than 85% of the inbound cargo handled is petroleum or petrochemicals. Based upon 1987 statistics, Corpus Christi ranks 7th in the U. S. in terms of movement of crude oil (19.5 million tons), and 4th in the movement of refined oil products (19.6 million tons, Reference 1).

The port complex is located within an environmentally sensitive coastal region which, in addition to sensitive wetlands. also supports significant commercial and sports fisheries.

2.2 OVERVIEW OF THE PORT

The Port of Corpus Christi lies on the west side of Corpus Christi Bay, about 20 miles inland from the outer end of the Aransas Pass jetties. The Bay is part of a waterway complex extending along the Texas coast from just southeast of Galveston to approximately its border with Mexico. This complex is separated from the Gulf of

Mexico by an extended series of low-lying and elongated islands, and the sheltered water habitat thus created is important to the support of a variety of aquatic life. The port consists of a series of artificial channels superimposed upon the natural configuration.

The climate is characterized as "intermediate", somewhere between humid and subtropical and semi-arid. This combination provides a climate markedly different from that of the Eastern Gulf, with little rainfall during the summer months except as produced by the occasional tropical storm. Because of the proximity of the Gulf, humidity tends to be high except during afternoons, when it usually drops to 50-60%. Visibility, particularly at the port's seaward entrance, reduces to less than a quarter mile during about 29 days per year, (Reference 2) primarily between November and April.

The diurnal tidal range is about 1.4 feet at Aransas Pass, but is negligible in Corpus Christi Bay itself. Tidal current velocities within Aransas Pass are strong at times, reaching upwards of 2.5 knots, and are greatly affected by winds. Just outside Aransas Pass velocities as high as 4 knots have been experienced across the jetties. Easterly winds tend to make a rough bar, and can raise the depth of water inside the Pass as much as two feet above normal levels. Westerly winds tend to reduce the depth of water in a similar but opposite fashion.

The approach to the port from seaward is through a series of Safety Fairways designed to insure unobstructed passage of deep-draft shipping through the profusion of offshore activity present throughout Gulf inshore waters. The Aransas Pass Safety Fairway, constituting the approach from the southeast, is unique in that parts of it consist of two parallel fairways instead of a single one. Although the parallel fairways are in no sense a Traffic Separation Scheme, inbound ships generally use the northeast fairway and outbound the southwest. Approach navigation is facilitated by Loran-C coverage providing good crossing angles, an aid of particular importance when making landfall upon a low-lying, unrelieved coastline in reduced visibility. There are two Federal Fairway Anchorages in the approaches outside of the sea buoy.

Pilotage is compulsory for all foreign-flag vessels and U. S. ships under registry in foreign trade. Pilotage is optional for U. S.-flag ships in coastwise trade that have on board a Federally licensed pilot. Pilotage is provided by the Aransas-Corpus Christi Pilots, who maintain a pilot station on the South Jetty. The Pilot Station monitors VHF-FM Channels 12 and 16, and uses CH12 as the Pilot working frequency. Pilots board inbound ships between Aransas Pass Entrance Lighted Whistle Buoy AP and Aransas Pass Lighted Buoy 3.

A series of Federally-maintained channels carries traffic from the Aransas Pass outer bar inward to the Viola Turning Basin, some 28.5 miles from the outer bar. Controlling depth for the overall

project is 45' at Mean Lower Low Water (MLLW), with some portions maintained to 47' MLLW. Channel width is 600'-700', broadening briefly at several locations to form turning basins. More definitive information about channel dimensions is contained in the Tabulation printed with Chart No. 11309. There are no anchorages for large ships inside Aransas Pass and ships awaiting entry or berths anchor in the Aransas Pass Fairway Anchorages established by 33CFR166.200. It should be noted that ships are occasionally permitted to anchor at short stay and for brief periods in the larger turning basins. In general, the channels are well marked by a combination of buoys, fixed aids and mid-channel ranges. The ranges are particularly important because of the long reaches of dredged channels and the general absence of prominent landscape features. The deep-draft channel is intersected by a series of shoal draft channels, including the Intracoastal Waterway (ICW), some of which coincide for short stretches with the deep-draft channel. Barge traffic is moderately heavy, particularly when transiting ICW shipping is included.

The offshore support industry is only a minor presence in the port and its contribution to the total vessel movement volume may be considered insignificant. The port area hosts significant recreational and fishing fleets. In general, recreational boating activity does not extend into the deep-draft channel and is actively prohibited within specific areas of the commercial port. The fishing fleet, while adding to the total traffic volume, probably impacts traffic management most through its contribution to the degradation of VHF-FM communications.

A little over 1500 yards inside the jetties the main entrance channel splits into three separate routes. The Lydia Ann Channel, branching to the North Northeast (NNE) is a shoal-draft channel serving as an alternate leg of the ICW and is used by barge traffic. It also forms a route transited by fishing vessels enroute both to the Gulf and to the shrimping grounds of Aransas Bay. The Aransas Channel, essentially a shoal draft extension of the Jetty Channel, serves facilities located at Aransas Pass. The main channel turns to the West Southwest (WSW), running between Harbor and Mustang Islands.

There is considerable vessel activity centered around or near the point of trifurcation. Port Aransas, for example, is a fishing and resort town supporting a municipal marina, a number of private boatyards, moorages and other water-related activities. An automobile ferry crosses the main channel about 700 yards west of Cline Point. Three major crude oil terminals are located on the south side of Harbor Island, along the north side of the main channel. The assumption can be made that most of the ships servicing those terminals are turned at or just west of the Port Aransas Inner Basin.

West of Harbor Island the main channel lies across the southern end of Redfish Bay where it intersects and crosses the ICW just to the

east of Port Ingleside. In addition to crossing the ICW flow, barge traffic between Corpus Christi and the ICW joins deep-draft shipping at this point and shares the channels with it to the heads of deep-draft navigation at the La Quinta and Viola Turning Basins. The low elevations of the adjoining land help make vessels in the main channel and the ICW visible to each other prior to their arrival at the intersection.

A crude oil and petroleum shipping and bunkering terminal is sited at Port Ingleside, and a barge fleeting area is located to the south of the main channel just opposite. About a mile to the west, the main channel splits into two deep-draft channels; the La Quinta Channel extending northward to the piers of a large aluminum plant located at La Quinta Turning Basin. The Corpus Christi Channel proceeds westward across Corpus Christi Bay for some nine miles before entering the channels which form the port of Corpus Christi proper.

To the south of the Corpus Christi Channel and lying along the city's front upon Corpus Christi Bay is a large municipal marina serving about 600 recreational boats. By Port Authority regulation these are barred from the port area proper and so are not a significant factor in traffic management. The port has over 45 acres of open storage, 2 million square feet of covered storage and over 900,000 cubic feet of cold storage space. Mobile and stationary cranes to 600 tons are available. Although there are some repair facilities, there is no major drydock or ship building activity. A complete listing of facilities is contained in Volume 25 of the U. S. Army Corps of Engineers Port Series.

It should be noted that there are a number of oil platforms sited in Corpus Christi and Redfish Bays. Active and inactive pipelines may pass under the floor of the main channel near these structures, making emergency use of anchors hazardous to the environment.

Basic traffic management requirements, considering only deep-draft ships, are quite simple. Adequate advance notice of movements coupled with regulation of departures, entrances and queuing would suffice to virtually eliminate multi-ship incidents. To this extent, the requirements are quite similar to those of Lake Charles and Port Arthur. Similar complexities are introduced by the potential for interaction between deep- and shoal-draft shipping, particularly at channel intersections and by the concentration of activities at specific points, such as Port Ingleside and Port Aransas.

2.3 EXISTING TRAFFIC MANAGEMENT

The Port of Corpus Christi Authority exercises control over the port through the Harbormaster. This official assigns berths and enforces port regulations, including a 4 knot speed limit within the port area. The Harbormaster's Office, located on Corpus Christi Wharf No. 1 guards VHF-FM Channels 12 & 16. In addition,

the Harbormaster provides typical Marine Exchange services; recording statistics, providing information to terminal operators, agents, shipping lines and others. The U. S. Coast Guard Captain of the Port (COTP) asserts Federal authority in those matters for which the Port Authority lacks jurisdiction or when Federal interests become paramount.

Port Authority regulation, coupled with "understandings" with the pilots, have combined to create a de facto traffic management regime for deep-draft ships. Procedures, unpublished in the Coast Pilot or similar publication, include special restrictions for ships 900' length overall (LOA). These special restrictions include daylight-only transit, one-way traffic and two pilots on board. Reporting requirements have also been established for ships carrying pilots.

A local perception views the existing system as a Vessel Traffic Service, but it has not been recognized as such either through the Federal Regulation process or by the International Maritime Organization (IMO).

2.3.1 General Management Problems

Several problems complicate traffic management, but these are not unique to the Corpus Christi area. Many mariners report improper use of Channel 13 through excessive transmitter power and using the channel for traffic not related to the safety of navigation. Other than communications, most of the remaining problems seem to focus upon conflict between the different users; most notably failure of small craft to yield to deep-draft ships constrained by the channel and between ships and tugs/tows using the ICW.

The towboat industry experiences problems focused upon pilothouse workload and communications requirements. The tugs normally operate with a single person on watch in the pilothouse. In addition to piloting the tug and tow the pilothouse watch must also handle communications and perform a number of internal functions. As a result, the watchstander reportedly becomes saturated which frequently results in failure to guard or to communicate intentions on Channel 13.

While good information is generally available about the movements and cargoes of deep-draft shipping, a similar volume of data is not available to those concerned with traffic management about ICW and other barge traffic. This absence of information complicates the process of merging such inland traffic smoothly and safely with deep-draft shipping, and uncertainties about inland cargoes may inhibit adequate pollution prevention and response.

These problems are of significance to system design. The most obvious impact is to impose surveillance requirements where they would otherwise not exist in order to cover known shortfalls of information. The difficulties of incorporating barge data into the information management database also represents a major challenge.

2.3.2 Regulated Navigation Areas

Moving Safety Zones are established by the COTP for 500 yards around loaded liquified petroleum gas (LPG) vessels transiting Corpus Christi Channel between the outer end of the Aransas Pass jetties and Port of Corpus Christi Oil Dock No. 11. Ships moor at the Trunkline LNG Terminal. (See 33CFR165.808).

33CFR165.23 establishes the General Regulations applicable to Safety Zones, quoted in its entirety herein.

"Unless otherwise provided in this part-
(a) No person may enter a safety zone unless authorized by the COTP or the District Commander;
(b) No person may bring or cause to be brought into a safety zone any vehicle, vessel or object unless authorized by the COTP or the District Commander;
(c) No person may remain in a safety zone or allow any vehicle, vessel or object to remain in a safety zone unless authorized by the COTP or the District Commander.
(d)Each person in a safety zone who has notice of a lawful order or direction shall obey the order or direction of the COTP or District Commander issued to carry out the purposes of this subpart."

2.4 VESSEL TRAFFIC

The preponderance of deep-draft movements involve the carriage of petro-chemicals and hazardous material, with the largest ships, in terms of bulk, being VLCC's. (Largest ship to call at Corpus Christi is the 234,000 Deadweight "Nore Adventure". In addition to petro-chemicals and hazardous materials, there is significant bulk trade in bauxite and grain. The nature of goods moving within the port complex via barge is more varied, with reliable data not available about percentages of petro-chemicals and hazardous materials. (Discussions with towboat operators, however, indicated that a significant percentage of the tows carried at least some hazardous materials)

Good movement statistics for deep-draft ships are available from the Harbormaster, with the total number of tank ship movements approaching an average of 1000 per year during 1987. Reliable barge traffic data is available for only certain segments of the total trade, particularly when ICW traffic passing through but not calling within the port is considered. The overall volume may, however, be considered heavy. In 1987, for example, there were 8743 movements of oil barges within the port (Reference 3).

2.5 ENVIRONMENTAL SENSITIVITY

The entire waterway complex between the offshore islands and the Port of Corpus Christi itself, and to the north and south of the port area supports a variety of aquatic fowl, fish and mammals. To the north, part of the complex is included in the Aransas National Wildlife Refuge, a nesting site for the known species of Whooping Crane. Padre Island, which forms the seaward side of Laguna Madre south of the port area is the primary portion of the Padre Island National Seashore under jurisdiction of the Department of Interior.

The usual marshlands ecological fragility applies to much of the Laguna Madre-Corpus Christi Bay-Redfish Bay-Aransas Bay area, and it is clear that a pollution incident occurring inside the jetties could harm a large-sized area. The "Worst-Case" pollution scenario probably is a major spill of crude oil inside the barrier islands, coupled by a wind which would spread the pollutant across the entire embayed shoreline. Pollution incidents inside the jetty should be, with some notable exceptions, amenable to containment because of the sheltered nature of the waterway and the general absence of current.

The "Most-Likely" scenario is an incident between a ship and tow, or between two tows, probably occurring at one of the channel intersections. The greatest threat resulting from the most likely incident is the release of hazardous material, particularly as vapor into the atmosphere. An incident resulting in a prolonged closure of the main channel seaward of Harbor Island would probably have the greatest economic impact. Should this result in temporary closure of one or more refineries, costs substantially over $1 million per day could be incurred.

2.6 PORT SUB-ZONES

The port was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 4). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous.

2.6.1 Sub-Zone I - Corpus Christi Approaches (NOAA Chart 11300)

Sub-Zone I consists of the Gulf Approaches to the Port of Corpus Christi seaward of a line between 27^0-46.3'N 97^0-06'W, 27^0-30'N 96^0-48.8'W, 27^0-52'N 96^0-40.5'W and 27^0-59'N 96^0-56'W.

The Approaches provide an opportunity to initiate queuing for port entry, including adjustment of estimated times of arrival (ETA) in order to minimize waiting periods spent either at anchor or standing off. This is particularly important for ships over 900' LOA, given the existing one-way rule which applies to them, and the length of the Corpus Christi Main Channel.

The sub-zone is classified as "confined-simple". Confinement accrues from the necessity to remain within the Safety Fairways.

2.6.2 Sub-Zone II - Aransas Pass (NOAA Chart 11309)

Sub-Zone II consists of that portion of the waterway inshore of Sub-Zone I and seaward of the COLREGS demarcation line.

The sub-zone includes the pilot boarding area and the Aransas Pass Fairway Anchorages. Management of traffic within this sub-zone is critical to the overall flow within the port and particularly to the avoidance of congestion or interference at the Port Aransas Junction in Sub-Zone III.

The sub-zone is classified as "confined-simple."

2.6.3 Sub-Zone III - Harbor Island (NOAA Charts 11300 & 11309)

Sub-Zone III is bounded to the east by the COLREGS demarcation line, to the north by an east-west line drawn across Aransas Bay at ICW Light 79, by a line across Aransas Channel at Aransas Channel Light 10, and a line across Corpus Christi Main Channel between Lights 13 and 14.

The Harbor Island sub-zone embraces a junction point where four channels meet, major crude oil terminals, ferry and small craft activity.

The Sub-Zone is classified as "confined-complex."

2.6.4 Sub-Zone IV - Port Ingleside (NOAA Chart 11309)

Sub-Zone IV is bounded to the east by a line across Corpus Christi Main Channel between Lights 13 and 14, to the north by a line across Redfish Bay at 27^0-55' North Latitude, to the south by a line across Corpus Christi Bay at 27^0-45' North Latitude from Mustang Island to 97^0-16' West Longitude. The western limit is 97^0-16' West Longitude from its intersection with 27^0-45' North Latitude northward to the shoreline. Port Aransas, Port Ingleside and the La Quinta Channel are included in this sub-zone.

The Port Ingleside sub-zone is potentially the busiest and most challenging, from the traffic management standpoint, within the port. It includes channel intersections, a mixing of barge and deep-draft traffic and terminal activities.

The sub-zone is classified as "confined-complex."

2.6.5 Sub-Zone V - Corpus Christi (NOAA Chart 11311)

Sub-Zone V consists of that portion of the Port of Corpus Christi lying north of 27^0-45' North Latitude and west of 97^0-16' West Longitude.

Although channels within this sub-zone are shared by shallow-and deep-draft traffic encounters are generally confined to meetings and overtakings. This tends to simplify overall management, enhancing the ability to adjust traffic flow to accommodate maneuverings to make or clear piers.

The sub-zone is classified as "confined-simple."

2.7 PROBLEM AREA IDENTIFIER (TABLE 2-1)

2.7.1. PAI-1 Aransas Pass Fairway Anchorages

The Aransas Pass Fairway Anchorages represent one of the resources available to adjust deep-draft traffic flow within the port proper. Although these are not at present congested the ability to manage them using specific knowledge of ship locations within them will become increasingly important as traffic volume increases or the size of deep-draft ships grow.

2.7.2 PAI III-1 Port Aransas Junction

At any point where two or more channels meet, the potential for multi-ship incidents exist. This potential is greatly increased when four channels meet at a point where there is a heavy volume of other activity. At this location, in addition to the juncture of four channels, there are three major oil terminals, turning basins, small craft activity and a ferry crossing. A significant percentage of the smaller craft transiting the Junction are "non-participants", in that they fall below the threshold required to guard Channel 13.

Tidal sensors located within this PAI will, in conjunction with sensor(s) further west, assist in identifying tidal variations imposed by wind conditions.

2.7.3 PAI IV-1. Port Ingleside

The general comments applicable to PAI III-1 also apply to Port Ingleside. The activities are somewhat different and are probably more hazardous than at Port Aransas Junction. ICW traffic passes through the Main Channel at nearly right angles, shoal-draft leave and depart the main channel here, and barge fleeting with all of its bustle and confusion takes place in close proximity to a major terminal.

TABLE 2-1. CORPUS CHRIST, TX PROBLEM AREA IDENTIFIERS

PAI #	LOCATION	PROBLEM	MANAGEMENT
II-1	Fairway Anchorages	Anchorage management critical to queuing and safety	Have real-time knowledge of ship location and movement coupled with ability to coordinate movements with queuing requirements.
III-1	Port Aransas Junction	Recreational boats and fishing craft based at or near Port Aransas are "non-participants" in Channel 13, current management scheme. Ferry crossing every 15 minutes adds to congestion. Ships maneuvering to make or clear Harbor Island terminals add to management concerns. Real-time tidal information needed to allow for wind effect.	Have real-time knowledge of both participant and Non-participant locations and movement. Be able to correlate all movements, provide movement management advice and alerting. Real-time tidal information Visibility information
IV-1	Port Ingleside	Intersecting channels and merging of traffic types plus the level of activity around Port Ingleside introduce significant risk of incidents.	Have real-time knowledge of both participant and non-participant locations and movement. Be able to correlate all movements, provide movement management advice and alerting.
IV-2	La Quinta Junction	Intersecting channels and merging of traffic types introduces significant risk of incidents	Manage traffic flows to prevent interaction between traffic
V-1	Corpus Christi Bay	Tidal levels can be greatly affected by winds	Provide real time tidal and visibility information

2.7.4 PAI IV-2. La Quinta Junction

The La Quinta Junction, where the Main and La Quinta Channels meet, represents a point where both shoal- and deep-draft traffic flows converge and separate. Shipping outbound from the La Quinta Channel must cross the path of traffic inbound for Corpus Christi while making a major course alteration and adjusting arrival at the Port Ingleside area so as to minimize problems there.

2.7.5 PAI V-1. Corpus Christi Bay

Although traffic management issues within all of Sub-Zone V are straight-forward, tidal sensors located within this PAI will, in conjunction with sensor(s) to the east, assist in identifying tidal variations imposed by wind conditions.

3.0 CORPUS CHRISTI PORT VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port Corpus Christi is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed (Reference 1). These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The five sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of

ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Corpus Christi VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 Hardware Location and Selection

3.2.1.1 Sub-Zone III

Harbor Island (Inner Basin)	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET 1 Module 15 HYD

3.2.1.2 Sub-Zone IV

McGlown Bluff	1 Module 3 radar 1 Module 10 VHF

3.2.1.3 Sub-Zone V

USCG Dock	1 Module 10 VHF 1 Module VHF 1 Module 15 HYD
Interstate Grain Terminal	1 Module 10 VHF 1 Module 13 MET

3.2.2 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located at Port Aransas in a location with good visual surveillance of the ship channels. The center is to employ the following equipment:

3.2.2.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Required Communications coverage provided from Sub-Zone III
II																			Required Comms/Radar coverage provided from Sub-Zone III
III			1							1	1		1		1				
IV			1							1									
V										2	1		1		1				

FIGURE 3-1. **CORPUS CHRISTI, TX SURVEILLANCE SURVEY**

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.2.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.2.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.2.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Corpus Christi VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation one supervisory console & all software)	750	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	100	
Sub-total:	1000	500

Sub-Zone I

No hardware located in this sub-zone

Required comms coverage from Sub-Zone III

Sub-Zone II

No hardware located in this sub-zone
Required radar/comms coverage from Sub-Zone III

Sub-Zone III

1 Module 3 Radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	20	5
1 Module 15 HYD	50	5
Sub-total:	537	443

Sub-Zone IV

1 Module 3 Radar	400	400
1 Module 10 VHF	19	13
Sub-total:	419	413

Sub-Zone V

2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
Sub-total:	176	56
HARDWARE TOTALS	2132	1412

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$2132
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1066
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no serious problem, three accessible sites	213
Spares & Training (10%)	213
Civil Engineering 1 remote & 1 local radar sites, a VTC in Port Aransas area several remote comms and WX sensors installations, minor land acquisition	1000
PROJECT ESTIMATE:	4624
Data Base Management System	300
TOTAL: (non-recurring)	$4924

Recurring (10 year)

Hardware	1912
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Watch Supervisor (half-time)	1250
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 6662
TOTAL 10-YEAR PROJECT COST:	$11586

REFERENCES

1. Summary Statistics on Leading U. S. Ports, Center for Marine Conservation, Washington, D. C. 22 March 1990

2. United States Coast Pilot, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands, 21st Edition, NOAA, Washington, D. C., Page T-11.

3. Summary Statistics on Leading U. S. Ports, Center for Marine Conservation, Washington, D. C. 22 March 1990.

4. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, Pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1001A		
2413	A	CHANNEL TO ARANSAS PASS, TEX.
2418	A	HARBOR ISLAND, TEX.
2418	B	HARBOR ISLAND, TEX.
2423	A	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI
Subzone 1002B		
2413	A	CHANNEL TO ARANSAS PASS, TEX.
2418	A	HARBOR ISLAND, TEX.
2418	B	HARBOR ISLAND, TEX.
2423	A	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI
Subzone 1003E		
2413	A	CHANNEL TO ARANSAS PASS, TEX.
2413	B	CHANNEL TO ARANSAS PASS, TEX.
2418	A	HARBOR ISLAND, TEX.
2418	B	HARBOR ISLAND, TEX.
2423	A	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI
2423	B	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI
6244	A	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
6244	B	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.
Subzone 1004F		
2423	A	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI
2423	B	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1001A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	971,504	0	8,525	0	980,029
4	MINING PRODUCTS, NEC	5,076,654	0	24,489	0	5,101,143
5	PROC. FOODS & MFTRS, NEC	2,298,146	0	1,657,218	0	3,955,364
6	WASTE OF MANUFACTURING	6,532	0	8,600	0	15,132
1311	CRUDE PETROLEUM	1,113	20,471,442	0	1,148,432	21,620,987
1493	SULPHUR, LIQUID	0	0	0	45,362	45,362
2810	SODIUM HYDROXIDE (CAUSTI	0	0	327,884	0	327,884
2811	CRUDE PROD-COAL TAR-PET	333	0	212,550	0	212,883
2813	ALCOHOLS	0	0	0	577,049	577,049
2817	BENZENE AND TOLUENE	0	12,507	0	638,732	651,239
2871	NITROGEN CHEM FERTILIZER	0	65,418	0	58,579	123,997
2872	POTASSIC CHEM FERTILIZER	6,011	0	0	0	6,011
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,986	0	2,986
2911	GASOLINE, INCL NATURAL	0	5,043,185	0	3,480,534	8,523,719
2912	JET FUEL	0	292,875	0	170,198	463,073
2913	KEROSENE	0	4,128	0	177,337	181,465
2914	DISTILLATE FUEL OIL	743	3,551,345	0	1,287,858	4,839,946
2915	RESIDUAL FUEL OIL	0	4,281,243	0	2,116,990	6,398,233
2916	LUBRIC OILS-GREASES	0	8,999	0	9,939	18,938
2917	NAPHTHA, PETRLM SOLVENTS	0	1,220,603	0	353,497	1,574,100
2921	LIQUI PETR-COAL-NATR GAS	0	158,564	0	14,376	172,940
	Subzone Total :	8,361,036	35,110,309	2,242,252	10,078,883	55,792,480

Subzone 1002B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	971,504	0	8,525	0	980,029
4	MINING PRODUCTS, NEC	5,076,654	0	24,489	0	5,101,143
5	PROC. FOODS & MFTRS, NEC	2,298,146	0	1,657,218	0	3,955,364
6	WASTE OF MANUFACTURING	6,532	0	8,600	0	15,132
1311	CRUDE PETROLEUM	1,113	20,471,442	0	1,148,432	21,620,987
1493	SULPHUR, LIQUID	0	0	0	45,362	45,362
2810	SODIUM HYDROXIDE (CAUSTI	0	0	327,884	0	327,884
2811	CRUDE PROD-COAL TAR-PET	333	0	212,550	0	212,883
2813	ALCOHOLS	0	0	0	577,049	577,049
2817	BENZENE AND TOLUENE	0	12,507	0	638,732	651,239
2871	NITROGEN CHEM FERTILIZER	0	65,418	0	58,579	123,997
2872	POTASSIC CHEM FERTILIZER	6,011	0	0	0	6,011
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,986	0	2,986
2911	GASOLINE, INCL NATURAL	0	5,043,185	0	3,480,534	8,523,719
2912	JET FUEL	0	292,875	0	170,198	463,073
2913	KEROSENE	0	4,128	0	177,337	181,465
2914	DISTILLATE FUEL OIL	743	3,551,345	0	1,287,858	4,839,946
2915	RESIDUAL FUEL OIL	0	4,281,243	0	2,116,990	6,398,233
2916	LUBRIC OILS-GREASES	0	8,999	0	9,939	18,938
2917	NAPHTHA, PETRLM SOLVENTS	0	1,220,603	0	353,497	1,574,100
2921	LIQUI PETR-COAL-NATR GAS	0	158,564	0	14,376	172,940
	Subzone Total :	8,361,036	35,110,309	2,242,252	10,078,883	55,792,480

Appendix J Zone 10 Corpus Christi, TX 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1003E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	971,504	0	8,525	0	980,029
4	MINING PRODUCTS, NEC	5,076,654	0	24,489	0	5,101,143
5	PROC. FOODS & MFTRS, NEC	2,298,146	0	1,657,218	0	3,955,364
6	WASTE OF MANUFACTURING	6,532	0	8,600	0	15,132
1311	CRUDE PETROLEUM	1,113	20,471,442	0	1,148,432	21,620,987
1493	SULPHUR, LIQUID	0	0	0	45,362	45,362
2810	SODIUM HYDROXIDE (CAUSTI	0	0	327,884	0	327,884
2811	CRUDE PROD-COAL TAR-PET	333	0	212,550	0	212,883
2813	ALCOHOLS	0	0	0	577,049	577,049
2817	BENZENE AND TOLUENE	0	12,507	0	638,732	651,239
2871	NITROGEN CHEM FERTILIZER	0	65,418	0	58,579	123,997
2872	POTASSIC CHEM FERTILIZER	6,011	0	0	0	6,011
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,986	0	2,986
2911	GASOLINE, INCL NATURAL	0	5,043,185	0	3,480,534	8,523,719
2912	JET FUEL	0	292,875	0	170,198	463,073
2913	KEROSENE	0	4,128	0	177,337	181,465
2914	DISTILLATE FUEL OIL	743	3,551,345	0	1,287,858	4,839,946
2915	RESIDUAL FUEL OIL	0	4,281,243	0	2,116,990	6,398,233
2916	LUBRIC OILS-GREASES	0	8,999	0	9,939	18,938
2917	NAPHTHA, PETRLM SOLVENTS	0	1,220,603	0	353,497	1,574,100
2921	LIQUI PETR-COAL-NATR GAS	0	158,564	0	14,376	172,940
	Subzone Total :	8,361,036	35,110,309	2,242,252	10,078,883	55,792,480

Subzone 1004F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	971,504	0	8,525	0	980,029
4	MINING PRODUCTS, NEC	5,074,987	0	23,747	0	5,098,734
5	PROC. FOODS & MFTRS, NEC	2,295,533	0	1,655,438	0	3,950,971
6	WASTE OF MANUFACTURING	6,532	0	5,700	0	12,232
1311	CRUDE PETROLEUM	0	18,655,280	0	819,079	19,474,359
1493	SULPHUR, LIQUID	0	0	0	45,362	45,362
2810	SODIUM HYDROXIDE (CAUSTI	0	0	327,884	0	327,884
2811	CRUDE PROD-COAL TAR-PET	333	0	212,550	0	212,883
2813	ALCOHOLS	0	0	0	577,049	577,049
2817	BENZENE AND TOLUENE	0	12,507	0	638,732	651,239
2871	NITROGEN CHEM FERTILIZER	0	65,418	0	51,922	117,340
2872	POTASSIC CHEM FERTILIZER	6,011	0	0	0	6,011
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,986	0	2,986
2911	GASOLINE, INCL NATURAL	0	5,043,185	0	3,480,534	8,523,719
2912	JET FUEL	0	292,875	0	170,198	463,073
2913	KEROSENE	0	4,128	0	177,337	181,465
2914	DISTILLATE FUEL OIL	0	3,551,345	0	1,261,532	4,812,877
2915	RESIDUAL FUEL OIL	0	4,144,086	0	2,107,026	6,251,112
2916	LUBRIC OILS-GREASES	0	8,999	0	9,939	18,938
2917	NAPHTHA, PETRLM SOLVENTS	0	1,220,603	0	353,497	1,574,100
2921	LIQUI PETR-COAL-NATR GAS	0	158,564	0	14,376	172,940
	Subzone Total :	8,354,900	33,156,990	2,236,830	9,706,583	53,455,303

7/22/91

Appendix J ZONE 10 Corpus Christi, TX

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 10 Corpus Christi, TX

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	147,725	147,725
Dry Cargo	498	620	2,664	3,782
Tanker	1,312	1,030	165	2,507
Dry Cargo Barge Tow	0	0	1,744	1,7[illegible]5
Tanker Barge Tow	27	0	8,740	8,768
Tug/Tow Boat	0	0	5,571	5,571
Zone Total:	1,838	1,650	166,610	170,098

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

7/22/91

Appendix J ZONE 10 Corpus Christi, TX

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1001A				
Passenger	0	0	1,459	1,459
Dry Cargo	498	620	225	1,343
Tanker	1,312	1,030	156	2,498
Dry Cargo Barge Tow	0	0	4	4
Tanker Barge Tow	27	0	259	286
Subzone Total:	1,838	1,650	2,103	5,591
Subzone : 1002B				
Passenger	0	0	1,459	1,459
Dry Cargo	498	620	225	1,343
Tanker	1,312	1,030	156	2,498
Dry Cargo Barge Tow	0	0	4	4
Tanker Barge Tow	27	0	259	286
Subzone Total:	1,838	1,650	2,103	5,591
Subzone : 1003E				
Passenger	0	0	147,725	147,725
Dry Cargo	498	620	2,664	3,782
Tanker	1,312	1,030	165	2,507
Dry Cargo Barge Tow	0	0	1,744	1,745
Tanker Barge Tow	27	0	8,740	8,768
Tug/Tow Boat	0	0	5,571	5,571
Subzone Total:	1,838	1,650	166,610	170,098
Subzone : 1004F				
Dry Cargo	249	313	67	629
Tanker	656	515	78	1,249
Dry Cargo Barge Tow	0	0	171	172
Tanker Barge Tow	27	0	2,962	2,989
Tug/Tow Boat	0	0	2,236	2,236
Subzone Total:	933	828	5,514	7,275

Note: Sum of all vessel transits within each study subzone.

Appendix J ZONE 10 Corpus Christi, TX

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 1001A		
2423	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI AND HARBOR ISLAND, TEX.)	3	3
	SUBZONE 1002B		
2423	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI AND HARBOR ISLAND, TEX.)	3	3
	SUBZONE 1003E		
2423	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI AND HARBOR ISLAND, TEX.)	3	3
6244	GULF INTRACOASTAL WATERWAY, GALVESTON TO CORPUS CHRISTI,TEX.(INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 1004F		
2423	CORPUS CHRISTI SHIP CHANNEL, TEX. (CORPUS CHRISTI AND HARBOR ISLAND, TEX.)	3	3

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix J Zone 10 Corpus Christi, TX

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1003E		7,964	82.10
1004F		6,000	3,157.89
	Total for Zone	13,964	19.84

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix J ZONE 10 Corpus Christi, TX 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1001A				
Passenger	0	0	1,536	1,536
Dry Cargo	631	792	271	1,694
Tanker	1,538	952	145	2,635
Dry Cargo Tow	0	0	204	204
Tanker Tow	24	0	3,271	3,295
Tug/Tow Boat	0	0	2,375	2,375
Subzone Total:	2,193	1,744	7,802	11,739
Subzone : 1002B				
Passenger	0	0	1,536	1,536
Dry Cargo	631	792	271	1,694
Tanker	1,538	952	145	2,635
Dry Cargo Tow	0	0	204	204
Tanker Tow	24	0	3,271	3,295
Tug/Tow Boat	0	0	2,375	2,375
Subzone Total:	2,193	1,744	7,802	11,739
Subzone : 1003E				
Passenger	0	0	162,388	162,388
Dry Cargo	631	792	2,857	4,280
Tanker	1,538	952	155	2,645
Dry Cargo Tow	0	0	2,028	2,028
Tanker Tow	24	0	9,106	9,130
Tug/Tow Boat	0	0	2,375	2,375
Subzone Total:	2,193	1,744	178,909	182,846
Subzone : 1004F				
Dry Cargo	340	434	93	867
Tanker	750	460	71	1,281
Dry Cargo Tow	0	0	198	198
Tanker Tow	24	0	3,003	3,027
Tug/Tow Boat	0	0	2,547	2,547
Subzone Total:	1,114	894	5,912	7,920

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix J ZONE 10 Corpus Christi, TX

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1001A				
Passenger	0	0	1,616	1,616
Dry Cargo	734	923	305	1,962
Tanker	1,749	1,013	167	2,929
Dry Cargo Tow	0	0	223	223
Tanker Tow	24	0	3,396	3,420
Tug/Tow Boat	0	0	2,747	2,747
Subzone Total:	2,507	1,936	8,454	12,897
Subzone : 1002B				
Passenger	0	0	1,616	1,616
Dry Cargo	734	923	305	1,962
Tanker	1,749	1,013	167	2,929
Dry Cargo Tow	0	0	223	223
Tanker Tow	24	0	3,396	3,420
Tug/Tow Boat	0	0	2,747	2,747
Subzone Total:	2,507	1,936	8,454	12,897
Subzone : 1003E				
Passenger	0	0	170,925	170,925
Dry Cargo	734	923	2,955	4,612
Tanker	1,749	1,013	177	2,939
Dry Cargo Tow	0	0	2,229	2,229
Tanker Tow	24	0	9,542	9,566
Tug/Tow Boat	0	0	2,747	2,747
Subzone Total:	2,507	1,936	188,575	193,018
Subzone : 1004F				
Dry Cargo	414	529	112	1,055
Tanker	849	489	82	1,420
Dry Cargo Tow	0	0	217	217
Tanker Tow	24	0	3,121	3,145
Tug/Tow Boat	0	0	2,921	2,921
Subzone Total:	1,287	1,018	6,453	8,758

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix J ZONE 10 Corpus Christi, TX

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1001A				
Passenger	0	0	1,673	1,673
Dry Cargo	857	1,088	347	2,292
Tanker	2,007	1,104	202	3,313
Dry Cargo Tow	0	0	245	245
Tanker Tow	23	0	3,515	3,539
Tug/Tow Boat	0	0	3,215	3,215
Subzone Total:	2,887	2,192	9,198	14,277
Subzone : 1002B				
Passenger	0	0	1,673	1,673
Dry Cargo	857	1,088	347	2,292
Tanker	2,007	1,104	202	3,313
Dry Cargo Tow	0	0	245	245
Tanker Tow	23	0	3,515	3,539
Tug/Tow Boat	0	0	3,215	3,215
Subzone Total:	2,887	2,192	9,198	14,277
Subzone : 1003E				
Passenger	0	0	176,903	176,903
Dry Cargo	857	1,088	3,050	4,995
Tanker	2,007	1,104	212	3,323
Dry Cargo Tow	0	0	2,451	2,451
Tanker Tow	23	0	9,981	10,004
Tug/Tow Boat	0	0	3,215	3,215
Subzone Total:	2,887	2,192	195,812	200,892
Subzone : 1004F				
Dry Cargo	505	654	137	1,296
Tanker	967	530	98	1,595
Dry Cargo Tow	0	0	238	238
Tanker Tow	23	0	3,232	3,256
Tug/Tow Boat	0	0	3,392	3,392
Subzone Total:	1,495	1,184	7,098	9,777

Note: Sum of all vessel transits within each study subzone.

Appendix J ZONE 10 Corpus Christi, TX

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1001A				
Passenger	0	0	1,731	1,731
Dry Cargo	1,004	1,291	398	2,693
Tanker	2,332	1,221	244	3,797
Dry Cargo Tow	0	0	269	269
Tanker Tow	23	0	3,649	3,671
Tug/Tow Boat	0	0	3,806	3,806
Subzone Total:	3,359	2,512	10,096	15,967
Subzone : 1002B				
Passenger	0	0	1,731	1,731
Dry Cargo	1,004	1,291	398	2,693
Tanker	2,332	1,221	244	3,797
Dry Cargo Tow	0	0	269	269
Tanker Tow	23	0	3,649	3,671
Tug/Tow Boat	0	0	3,806	3,806
Subzone Total:	3,359	2,512	10,096	15,967
Subzone : 1003E				
Passenger	0	0	183,091	183,091
Dry Cargo	1,004	1,291	3,149	5,444
Tanker	2,332	1,221	254	3,807
Dry Cargo Tow	0	0	2,694	2,694
Tanker Tow	23	0	10,465	10,488
Tug/Tow Boat	0	0	3,806	3,806
Subzone Total:	3,359	2,512	203,459	209,330
Subzone : 1004F				
Dry Cargo	616	813	170	1,599
Tanker	1,115	583	119	1,817
Dry Cargo Tow	0	0	262	262
Tanker Tow	23	0	3,357	3,379
Tug/Tow Boat	0	0	3,985	3,985
Subzone Total:	1,754	1,396	7,892	11,042

Note: Sum of all vessel transits within each study subzone.

Appendix J ZONE 10 Corpus Christi, TX 7/25/91

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	155,491	155,491
Dry Cargo	596	749	2,848	4,193
Tanker	1,538	952	155	2,645
Dry Cargo Tow	0	0	2,028	2,028
Tanker Tow	24	0	9,106	9,130
Tug/Tow Boat	0	0	2,375	2,375
1995 Zone Total:	2,158	1,701	172,003	175,862
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	163,666	163,666
Dry Cargo	668	840	2,938	4,446
Tanker	1,749	1,013	177	2,939
Dry Cargo Tow	0	0	2,229	2,229
Tanker Tow	24	0	9,542	9,566
Tug/Tow Boat	0	0	2,747	2,747
2000 Zone Total:	2,441	1,853	181,299	185,593
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	169,391	169,391
Dry Cargo	776	967	3,026	4,769
Tanker	2,007	1,104	212	3,323
Dry Cargo Tow	0	0	2,451	2,451
Tanker Tow	23	0	9,981	10,004
Tug/Tow Boat	0	0	3,215	3,215
2005 Zone Total:	2,806	2,071	188,276	193,153
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	175,316	175,316
Dry Cargo	905	1,141	3,119	5,165
Tanker	2,332	1,221	254	3,807
Dry Cargo Tow	0	0	2,694	2,694
Tanker Tow	23	0	10,465	10,488
Tug/Tow Boat	0	0	3,806	3,806
2010 Zone Total:	3,260	2,362	195,654	201,275

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix J Zone 10 Corpus Christi, TX 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1001A						
Dry Cargo	Small	1	0	0	0	1
Fishing	Small	5	0	0	0	5
Subzone Totals:		6	0	0	0	6
Subzone: 1002B						
Dry Cargo	Medium	1	0	0	0	1
Tanker	Large	0	0	1	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		2	0	1	0	3
Subzone: 1003E						
Passenger	Small	0	0	2	0	2
Dry Cargo	Large	0	1	1	0	2
Dry Cargo	Medium	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	1	0	0	2
Tanker Barge Tow	Small	2	0	4	0	6
Tug/Tow Boat	Small	0	3	3	0	6
Fishing	Small	2	1	0	0	3
Other	Small	3	2	2	0	7
Subzone Totals:		8	8	13	0	29
Subzone: 1004F						
Passenger	Small	1	0	0	0	1
Tanker	Large	0	0	2	0	2
Fishing	Small	1	0	0	0	1
Subzone Totals:		2	0	2	0	4
Zone Totals:		18	8	16	0	42

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE J-8 ZONE 10, CORPUS CHRISTI, TX - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
1001A																	III
1002B																	III
1003E	I	I	I	I	I	I	I	I	I	I	I	I					III
1004F	I	I	I	I	I	I	I	I	I	I	I	I					I

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

NOTE ALL COMMERCIAL VESSELS PARTICIPATE 1979 TO PRESENT

APPENDIX TABLE J-9 ZONE 10, CORPUS CHRISTI, TX
CANDIDATE VTS DESIGN - 1995-2010

UNITS

0	Radar Module 1 - Average Performance
0	Radar Module 2 - Average Performance
2	Radar Module 3 - High Performance
0	Radar Module 4 - High Performance
0	Radar Module 5 - Special Purpose
0	Radar Module 6 - Special Purpose
0	ADS Module 7 - Active Radar Transponder (Type 1)
0	ADS Module 8 - Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9 - Positional Transponder, Small Area, High Accuracy (Type 6)
4	VHF Module 10 - Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11 - High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12 - Air temperature, wind direction and speed
2	Meteorological Module 13 - Air temperature, wind direction and speed, visibility
0	Hydrological Module 14 - Water Temperature and Depth
2	Hydrological Module 15 - Water Temperature, Depth and Current
0	VHF/DF MODULE 16 - Line of position measurement to 2 degree RMS
0	CCTV MODULE 17 - Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18 - Remotely Controllable CCTV via

Appendix J Zone 10 Corpus Christi, TX

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	4.33	.62	3.49	8.44
Dry Cargo	Large	.52	.09	.63	1.24
Dry Cargo	Medium	.26	.04	.10	.41
Dry Cargo	Small	.21	.02	.03	.27
Tanker	Large	2.66	.62	3.61	6.89
Tanker	Medium	.19	.02	.11	.31
Tanker	Small	.01	0.00	.01	.03
Dry Cargo Barge T	Small	1.27	.37	.41	2.06
Tanker Barge Tow	Large	.01	.01	.01	.03
Tanker Barge Tow	Small	5.81	1.00	3.19	10.00
Tug/Tow Boat	Small	.15	.05	.09	.28
		15.42	2.84	11.68	29.94

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	3,799	546	2,176	6,521
Dry Cargo	Large	730	159	195	1,085
Dry Cargo	Medium	397	82	30	508
Dry Cargo	Small	148	17	19	185
Tanker	Large	19,419	4,631	15,555	39,605
Tanker	Medium	292	32	60	383
Tanker	Small	12	0	3	15
Dry Cargo Barge T	Small	71	58	7	136
Tanker Barge Tow	Large	217	101	86	404
Tanker Barge Tow	Small	27,010	4,694	2,538	34,242
Tug/Tow Boat	Small	11	8	6	26
		52,108	10,327	20,675	83,110

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 10B — Avoided Vessel Casualties 1996 - 2010
Existing VTS Systems — 7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	1.14	.32	.66	2.13
Dry Cargo	Large	.16	.04	.15	.36
Dry Cargo	Medium	.08	.02	.02	.13
Dry Cargo	Small	.06	.01	.01	.07
Tanker	Large	.80	.30	.87	1.97
Tanker	Medium	.06	.01	.03	.09
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge T	Small	.34	.20	.08	.62
Tanker Barge Tow	Large	.00	.00	.00	.01
Tanker Barge Tow	Small	1.64	.55	.65	2.84
Tug/Tow Boat	Small	.04	.03	.02	.09
		4.32	1.48	2.50	8.30

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	998	286	413	1,698
Dry Cargo	Large	224	80	49	354
Dry Cargo	Medium	122	41	8	170
Dry Cargo	Small	33	7	3	43
Tanker	Large	6,163	2,378	4,085	12,625
Tanker	Medium	91	16	15	121
Tanker	Small	3	0	0	3
Dry Cargo Barge T	Small	19	31	1	51
Tanker Barge Tow	Large	81	62	29	172
Tanker Barge Tow	Small	7,549	2,558	516	10,624
Tug/Tow Boat	Small	3	4	1	9
		15,287	5,463	5,121	25,870

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 voided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.28	.04	.22	.54
Dry Cargo	Large	.06	.01	.08	.15
Dry Cargo	Medium	.03	.01	.01	.05
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.40	.06	.32	.79
Candidate VTS Design - Dollars					
Passenger	Small	415,706.53	59,321.73	335,478.46	810,506.72
Dry Cargo	Large	96,288.29	16,553.98	114,278.68	227,120.95
Dry Cargo	Medium	48,960.61	7,989.77	18,618.83	75,569.21
Dry Cargo	Small	20,549.32	2,255.79	3,007.12	25,812.23
Tanker	Small	49.21	0.00	33.63	82.84
Dry Cargo Barge Tow	Small	4,199.25	1,223.56	1,371.22	6,794.04
Tanker Barge Tow	Small	19,222.04	3,295.10	10,538.30	33,055.44
Tug/Tow Boat	Small	479.91	159.76	285.40	925.06
Totals		605,455.16	90,799.69	483,611.63	1,179,866.48
Existing VTS Design - Counts					
Passenger	Small	.07	.02	.04	.14
Dry Cargo	Large	.02	.01	.02	.04
Dry Cargo	Medium	.01	.00	.00	.02
Dry Cargo	Small	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.11	.03	.07	.21
Existing VTS Design - Dollars					
Passenger	Small	109,228.39	31,107.67	63,733.24	204,069.29
Dry Cargo	Large	29,850.82	8,173.31	29,014.10	67,038.23
Dry Cargo	Medium	15,055.51	3,904.69	4,702.70	23,662.90
Dry Cargo	Small	4,964.45	853.69	370.93	6,189.08
Tanker	Small	11.75	0.00	5.46	17.20
Dry Cargo Barge Tow	Small	1,127.02	649.27	267.69	2,043.98
Tanker Barge Tow	Small	5,413.25	1,803.24	2,156.64	9,373.12
Tug/Tow Boat	Small	136.23	88.14	59.17	283.54
Totals		165,787.40	46,580.02	100,309.93	312,677.35

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	3.29	.47	2.65	6.41
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.00	.00	.00	.01
Dry Cargo	Small	.16	.02	.02	.20
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.01	.05
Tanker Barge Tow	Small	.14	.02	.08	.24
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		3.63	.52	2.78	6.93
Candidate VTS Design - Dollars					
Passenger	Small	782,782.29	111,702.99	631,711.06	1,526,196.35
Dry Cargo	Large	1,659.25	280.22	1,985.56	3,925.02
Dry Cargo	Medium	839.48	137.18	320.93	1,297.59
Dry Cargo	Small	38,694.71	4,247.70	5,662.45	48,604.86
Tanker	Small	78.24	0.00	58.64	136.89
Dry Cargo Barge Tow	Small	7,337.56	2,137.98	2,395.88	11,871.42
Tanker Barge Tow	Small	33,586.95	5,757.58	18,413.71	57,758.24
Tug/Tow Boat	Small	838.55	279.15	498.68	1,616.37
Totals		865,817.02	124,542.80	661,046.92	1,651,406.74
Existing VTS Design - Counts					
Passenger	Small	.86	.25	.50	1.61
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.04	.01	.00	.05
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.04	.01	.02	.07
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.95	.27	.53	1.75
Existing VTS Design - Dollars					
Passenger	Small	205,678.87	58,576.25	120,010.74	384,265.86
Dry Cargo	Large	512.53	138.70	498.16	1,149.40
Dry Cargo	Medium	258.50	67.04	80.74	406.29
Dry Cargo	Small	8,889.71	1,571.98	845.26	11,306.95
Tanker	Small	20.53	0.00	9.53	30.06
Dry Cargo Barge Tow	Small	1,969.25	1,138.28	467.04	3,574.58
Tanker Barge Tow	Small	9,458.64	3,150.83	3,768.32	16,377.79
Tug/Tow Boat	Small	238.03	154.01	103.40	495.44
Totals		227,026.06	64,797.09	125,783.20	417,606.36

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Candidate VTS Design - Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	3.69	.41	1.10	5.20
Dry Cargo	Large	.38	.06	.06	.51
Dry Cargo	Medium	.19	.03	.01	.23
Dry Cargo	Small	.18	.02	.02	.22
Tanker	Large	2.01	.50	.47	2.98
Tanker	Medium	.14	.01	.01	.16
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	.97	.16	.06	1.18
Tanker Barge Tow	Large	.01	.00	.00	.02
Tanker Barge Tow	Small	4.44	.42	.44	5.30
Tug/Tow Boat	Small	.03	.01	.01	.04
Totals		12.04	1.62	2.19	15.85

Candidate VTS Design - Dollars

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	1,257,664.53	140,276.94	562,376.30	1,960,317.77
Dry Cargo	Large	283,290.98	45,374.88	36,304.40	364,970.26
Dry Cargo	Medium	171,592.84	26,804.93	4,286.76	202,684.53
Dry Cargo	Small	34,778.89	3,106.80	4,211.43	42,097.13
Tanker	Large	1,578,700.18	391,684.94	1,019,035.44	2,989,420.56
Tanker	Medium	90,233.51	9,253.69	25,747.40	125,234.61
Tanker	Small	924.54	0.00	899.10	1,823.64
Dry Cargo Barge Tow	Small	56,281.39	9,081.12	2,934.09	68,296.59
Tanker Barge Tow	Large	2,013.59	523.87	332.85	2,870.32
Tanker Barge Tow	Small	314,742.46	29,875.60	40,063.69	384,681.75
Tug/Tow Boat	Small	1,831.11	391.52	1,058.87	3,281.49
Totals		3,792,054.02	656,374.29	1,697,250.34	6,145,678.65

Existing VTS Design - Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.97	.22	.21	1.40
Dry Cargo	Large	.12	.03	.02	.16
Dry Cargo	Medium	.06	.01	.00	.08
Dry Cargo	Small	.04	.01	.00	.05
Tanker	Large	.61	.24	.11	.96
Tanker	Medium	.04	.01	.00	.05
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.25	.08	.01	.34
Tanker Barge Tow	Large	.00	.00	.00	.01
Tanker Barge Tow	Small	1.25	.23	.09	1.57
Tug/Tow Boat	Small	.01	.00	.00	.01
Totals		3.35	.83	.45	4.63

Existing VTS Design - Dollars

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	330,457.45	73,559.69	106,838.64	510,855.77
Dry Cargo	Large	86,763.13	22,470.15	8,934.87	118,168.16
Dry Cargo	Medium	52,866.31	13,121.43	1,082.74	67,070.48
Dry Cargo	Small	7,834.62	1,174.32	691.43	9,700.37
Tanker	Large	475,974.19	188,452.61	245,375.25	909,802.06
Tanker	Medium	27,891.41	4,477.43	6,315.58	38,684.42
Tanker	Small	232.83	0.00	141.02	373.85
Dry Cargo Barge Tow	Small	14,793.08	4,837.34	571.99	20,202.41
Tanker Barge Tow	Large	688.67	286.04	95.27	1,069.98
Tanker Barge Tow	Small	88,636.72	16,349.39	8,198.93	113,185.04
Tug/Tow Boat	Small	519.78	216.00	219.55	955.33
Totals		1,086,658.19	324,944.41	378,465.28	1,790,067.87

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 **Avoided Cargo Damage/Loss 1996 - 2010**

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.91	.11	.30	1.32
Dry Cargo	Large	.14	.03	.06	.22
Dry Cargo	Medium	.07	.01	.01	.09
Dry Cargo	Small	.07	.01	.01	.08
Tanker	Large	.72	.18	.35	1.24
Tanker	Medium	.05	.00	.01	.06
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.18	.05	.02	.25
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.82	.14	.18	1.14
Tug/Tow Boat	Small	.01	.00	.00	.02
Totals		2.96	.53	.95	4.44
Candidate VTS Design - Dollars					
Passenger	Small	3,180.56	354.74	1,270.05	4,805.35
Dry Cargo	Large	1,458.53	350.97	164.70	1,974.20
Dry Cargo	Medium	731.27	169.03	26.52	926.81
Dry Cargo	Small	158.03	14.10	18.90	191.04
Tanker	Large	48,423.22	11,442.61	54,146.19	114,012.02
Tanker	Medium	675.20	67.77	126.43	869.40
Tanker	Small	11.44	0.00	5.11	16.56
Tanker Tow	Large	490.23	231.90	287.16	1,009.29
Tanker Tow	Small	97,381.92	16,699.57	21,743.73	135,825.21
Tug/Tow Boat	Small	22.04	4.71	12.41	39.16
Totals		152,532.44	29,335.39	77,801.20	259,669.03
Existing VTS Design - Counts					
Passenger	Small	.24	.06	.06	.35
Dry Cargo	Large	.04	.01	.01	.07
Dry Cargo	Medium	.02	.01	.00	.03
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Large	.22	.08	.08	.39
Tanker	Medium	.02	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.05	.03	.00	.08
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.23	.08	.04	.34
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.83	.27	.21	1.31
Existing VTS Design - Dollars					
Passenger	Small	835.70	186.02	241.28	1,263.01
Dry Cargo	Large	446.70	173.29	41.06	661.05
Dry Cargo	Medium	225.30	82.78	6.65	314.74
Dry Cargo	Small	40.88	7.21	3.46	51.54
Tanker	Large	15,900.18	5,993.09	14,380.15	36,273.42
Tanker	Medium	211.79	33.53	33.36	278.68
Tanker	Small	2.95	0.00	.85	3.80
Tanker Tow	Large	185.64	140.20	90.99	416.83
Tanker Tow	Small	30,016.39	9,998.95	4,870.04	44,885.38
Tug/Tow Boat	Small	6.26	2.60	2.57	11.43
Totals		47,871.80	16,617.66	19,670.41	84,159.87

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.07	.02	.09
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.00	.00	.01
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.07	.02	.09
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.04	.00	.04
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.11	.02	.13
Tug/Tow Boat	Small	0.00	.01	.00	.01
Totals		0.00	.32	.07	.39
Candidate VTS Design - Dollars					
Passenger	Small	0.00	398.82	112.91	511.73
Dry Cargo	Large	0.00	56.01	20.00	76.01
Dry Cargo	Medium	0.00	27.36	3.22	30.58
Dry Cargo	Small	0.00	15.17	1.01	16.18
Tanker	Large	0.00	402.11	116.63	518.74
Tanker	Medium	0.00	11.35	3.53	14.88
Tanker	Small	0.00	0.00	.35	.35
Dry Cargo Barge Tow	Small	0.00	238.96	13.40	252.36
Tanker Barge Tow	Large	0.00	4.15	.27	4.42
Tanker Barge Tow	Small	0.00	643.49	103.02	746.51
Tug/Tow Boat	Small	0.00	31.20	2.79	33.99
Totals		0.00	1,828.61	377.13	2,205.74
Existing VTS Design - Counts					
Passenger	Small	0.00	.04	.00	.04
Dry Cargo	Large	0.00	.00	.00	.01
Dry Cargo	Medium	0.00	.00	.00	.00
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.03	.00	.04
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.02	.00	.02
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.06	.00	.07
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.17	.01	.18
Existing VTS Design - Dollars					
Passenger	Small	0.00	209.14	21.45	230.59
Dry Cargo	Large	0.00	28.05	4.98	33.03
Dry Cargo	Medium	0.00	13.40	.81	14.21
Dry Cargo	Small	0.00	5.73	.15	5.88
Tanker	Large	0.00	193.47	28.08	221.55
Tanker	Medium	0.00	5.46	.87	6.33
Tanker	Small	0.00	0.00	.05	.05
Dry Cargo Barge Tow	Small	0.00	125.80	2.61	128.40
Tanker Barge Tow	Large	0.00	2.27	.08	2.34
Tanker Barge Tow	Small	0.00	352.15	21.08	373.23
Tug/Tow Boat	Small	0.00	17.21	.58	17.79
Totals		0.00	952.66	80.74	1,033.41

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.01	.04	0.00	.04
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.05	0.00	.05
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.02	0.00	.02
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.01	.06	0.00	.07
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.02	.18	0.00	.20
Candidate VTS Design - Dollars					
Passenger	Small	12,008.50	77,001.80	0.00	89,010.30
Dry Cargo	Large	0.00	13,216.32	0.00	13,216.32
Dry Cargo	Medium	0.00	6,294.29	0.00	6,294.29
Dry Cargo	Small	574.52	2,804.26	0.00	3,378.77
Tanker	Large	0.00	93,239.41	0.00	93,239.41
Tanker	Medium	0.00	2,632.95	0.00	2,632.95
Tanker	Small	30.68	0.00	0.00	30.68
Dry Cargo Barge Tow	Small	3,503.84	45,535.31	0.00	49,039.15
Tanker Barge Tow	Large	0.00	1,019.21	0.00	1,019.21
Tanker Barge Tow	Small	15,656.88	117,430.54	0.00	133,087.42
Tug/Tow Boat	Small	388.70	5,662.46	0.00	6,051.16
Totals		32,163.11	364,836.55	0.00	396,999.66
Existing VTS Design - Counts					
Passenger	Small	.00	.02	0.00	.02
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.03	0.00	.03
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.01
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.03	0.00	.03
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.10	0.00	.11
Existing VTS Design - Dollars					
Passenger	Small	3,164.83	40,527.26	0.00	43,692.09
Dry Cargo	Large	0.00	8,076.64	0.00	8,076.64
Dry Cargo	Medium	0.00	3,846.51	0.00	3,846.51
Dry Cargo	Small	151.41	1,475.92	0.00	1,627.34
Tanker	Large	0.00	56,979.64	0.00	56,979.64
Tanker	Medium	0.00	1,609.03	0.00	1,609.03
Tanker	Small	8.09	0.00	0.00	8.09
Dry Cargo Barge Tow	Small	923.43	23,965.95	0.00	24,889.39
Tanker Barge Tow	Large	0.00	622.85	0.00	622.85
Tanker Barge Tow	Small	4,126.35	61,805.55	0.00	65,931.90
Tug/Tow Boat	Small	102.44	2,980.24	0.00	3,082.68
Totals		8,476.56	201,889.60	0.00	210,366.15

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix J Zone 10 Corpus Christi, TX
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
SULPHUR, LIQUID	0.00	.00	.01	0.00	.01
ALCOHOLS	0.00	.04	.10	0.00	.14
BENZENE AND TOLUENE	.00	.05	.11	.00	.16
KEROSENE	.00	.00	.01	.00	.01
JET FUEL	.00	.00	.01	.00	.02
DISTILLATE FUEL OIL	.01	.04	.10	1.21	1.35
RESIDUAL FUEL OIL	.02	.06	.45	.69	1.22
GASOLINE, INCL NATURAL	.02	.08	.22	.00	.32
CRUDE PETROLEUM	.07	.14	.07	.01	.29
	.12	.43	1.07	1.91	3.53
Existing Vts Design - Counts					
SULPHUR, LIQUID	0.00	.00	.00	0.00	.00
ALCOHOLS	0.00	.01	.03	0.00	.04
BENZENE AND TOLUENE	.00	.01	.03	.00	.05
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.01	.03	.32	.36
RESIDUAL FUEL OIL	.01	.02	.15	.23	.40
GASOLINE, INCL NATURAL	.01	.03	.07	.00	.10
CRUDE PETROLEUM	.02	.04	.02	.00	.09
	.04	.13	.34	.55	1.05

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix J TABLE 18A | Zone 10 Corpus Christi, TX | 7/31/91

Annual Benefit & Cost Streams
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,924	0	0
1996	0	524	3,869
1997	0	477	3,576
1998	0	433	3,303
1999	0	394	3,051
2000	0	358	2,817
2001	0	326	2,610
2002	0	296	2,415
2003	0	269	2,234
2004	0	245	2,058
2005	0	222	1,887
2006	0	202	1,751
2007	0	184	1,636
2008	0	167	1,523
2009	0	152	1,403
2010	0	138	1,291
	4,924	4,387	35,424

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,924	0	0
1996	0	666	4,916
1997	0	666	4,998
1998	0	666	5,077
1999	0	666	5,160
2000	0	666	5,240
2001	0	666	5,341
2002	0	666	5,436
2003	0	666	5,531
2004	0	666	5,604
2005	0	666	5,654
2006	0	666	5,769
2007	0	666	5,929
2008	0	666	6,074
2009	0	666	6,152
2010	0	666	6,231
	4,924	9,993	83,110

Appendix J Zone 10 Corpus Christi, TX
TABLE 18B Annual Benefit & Cost Streams 7/31/91
Existing VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	1,206
1997	0	0	1,114
1998	0	0	1,029
1999	0	0	949
2000	0	0	877
2001	0	0	811
2002	0	0	750
2003	0	0	693
2004	0	0	640
2005	0	0	591
2006	0	0	548
2007	0	0	508
2008	0	0	471
2009	0	0	436
2010	0	0	404
	0	0	11,027

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	1,532
1997	0	0	1,557
1998	0	0	1,581
1999	0	0	1,604
2000	0	0	1,631
2001	0	0	1,659
2002	0	0	1,688
2003	0	0	1,716
2004	0	0	1,744
2005	0	0	1,770
2006	0	0	1,806
2007	0	0	1,842
2008	0	0	1,878
2009	0	0	1,913
2010	0	0	1,948
	0	0	25,870

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Port & Subzone	Christi Species Category	Species Code	(Port 10) Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1001	102	1	Alewife	.0010	.0010	.0010	.0010
1001	102	3	Atlantic Stingray	.0004	.0004	.0004	0.0000
1001	102	3	Gulf Menhaden	.0395	.0395	.0395	.0395
1001	102	5	Gulf Butterfish	.5920	.1050	.0493	.0158
1001	102	33	Spanish Mackerel	.0316	.0316	.0316	.0316
1001	102	42	Scaled Sardine	.0026	.0052	.0043	0.0000
1001	102	43	Atlantic Thread Herring	.0052	.0052	.0052	.0052
1001	102	43	Bay Anchovy	.0043	.0043	.0043	.0043
1001	102	43	Striped Anchovy	.0035	.0035	.0035	.0035
1001	102	44	Striped Mullet	.9700	.9700	.9700	.9700
1001	102	128	Searobins (all)	.0974	.5263	.0658	.0789
1001	102	130	Planehead Filefish	0.0000	.0158	0.0000	0.0000
1001	102	238	Gulf Menhanen	.0658	.0658	.0158	.0158
1001	103			.2000	.2000	0.0000	0.0000
1001	103	8	Bluefish	.4800	.0007	.4800	.8600
1001	103	11	Silver Sea Trout	3.1249	2.4999	2.4999	2.4999
1001	103	11	Weakfish	.0015	.0015	.0015	.0015
1001	103	50	Bonito	.0300	.0300	.0300	.0300
1001	103	51	Jack	.0070	.0070	.0070	.0070
1001	103	52	Amberjack	.0300	.0300	.0300	.0300
1001	103	54	Blue Runner	.0070	.0070	.0070	.0070
1001	103	55	Doulphin	.0030	.0060	.0030	.0030
1001	104	12	Tuna	.0080	.0080	.0080	.0080
1001	104	13	Swordfish	.0280	.0280	.0280	.0280
1001	104	14	Shark	.0100	.0100	.0100	.0100
1001	105			.5000	5.0000	1.0000	1.0000
1001	105	17	Summer Flounder	.0380	.2500	.2100	.2300
1001	105	56	Lefteye Flounders (all)	.3848	.1604	.7697	.3207
1001	105	57	Bay Wiff	0.0000	.1604	.1604	0.0000
1001	105	57	Fringed Flounder	.1604	.1604	.3208	.1604
1001	105	57	Gulf Flounder	0.0000	0.0000	0.0000	0.0000
1001	105	57	Ocellated Flounder	.0535	.0535	.0535	.0535
1001	105	57	Shoal Flounder	.1066	.1066	.1066	.0533
1001	105	237	Lesser Electric Ray	.0004	.0004	.0004	0.0000
1001	105	242	Lined Sole	.1539	.1539	.1539	.1539
1001	106		Silver Perch	.1105	.1105	.1105	.1105
1001	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
1001	106	28	Tilefish	.0390	.0390	.0390	.0390
1001	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
1001	106	34	Harvestfish	.0118	0.0000	.0237	.0985
1001	106	35	Atlantic Croaker	.6154	3.6925	.3077	.2564
1001	106	36	Banded Drum	.2762	.2525	.0789	.0789
1001	106	36	Star Drum	.3552	.2368	.4736	1.7762
1001	106	37	Spot	.2960	.5920	.0592	.1974
1001	106	40	Black Edge Cusk Eel	.0513	.0513	.0513	.0513
1001	106	40	Eels	.0011	.0011	.0011	.0011
1001	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
1001	106	47	Sand Sea Trout	.1499	.9375	2.4999	.2499
1001	106	48	Gafftopsail Catfish	.2130	.2130	.2130	.2130
1001	106	48	Hardhead Catfish	.1065	.3550	2.6641	.0710
1001	106	60	Longspine Porgy	0.0000	.3191	.3191	0.0000
1001	106	60	Porgies	.2000	.2000	.2000	.2000
1001	106	61	Florida Pompano	.0070	.0070	.0011	.0070

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Christi Port & Subzone	Species Category	(Port 10) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1001	106	62	Grunt	.0120	.0120	.0120	.0120
1001	106	63	Pinfish	.1053	.0329	.0329	.5263
1001	106	64	Southern Kingfish	.0789	.0395	.8223	.7890
1001	106	69	Red Snapper	0.0000	.5731	1.1462	0.0000
1001	106	71	Gulf Hake	.0316	.0316	.0316	.0316
1001	106	71	Southern Hake	.0316	0.0000	0.0000	.0316
1001	106	71	Spotted Hake	0.0000	0.0000	0.0000	0.0000
1001	106	76	Black ear Bass	0.0000	.0342	0.0000	.0427
1001	106	76	Rock Sea Bass	.0257	.0427	.0427	.0513
1001	106	76	Sea Bass	.0513	.0342	.0513	.0513
1001	106	77	Gray Triggerfish	.0986	.0986	.0986	.0986
1001	106	131	Rough Scad	.0189	0.0000	0.0000	0.0000
1001	106	132	Singlefoot Frogfish	.0158	.0158	.0158	.0158
1001	106	133	Other Batfish	.0197	.0197	.0197	.0197
1001	106	133	Pancake Batfish	0.0000	0.0000	.0197	.0395
1001	106	134	Inshore Lizardfish	.0631	.0631	.0421	.0316
1001	106	135	Atlantic Medshipmen	.0237	0.0000	.0237	.0158
1001	106	239	Atlantic Bumper	.0474	.0474	.0189	.0095
1001	106	240	Atlantic Moonfish	.3158	.0553	.0189	.0189
1001	106	241	Pigfish	.0329	.0329	.0329	.0658
1001	106	243	Hog Choker	.0974	.0158	.0316	.0316
1001	107			2.0000	20.0000	2.0000	2.0000
1001	108			.0160	.0480	.0160	.0160
1001	108	25	Brown Shrimp	.0493	.0493	.0099	.0025
1001	108	25	Pink Shrimp	.0395	.0025	.0025	.0025
1001	108	25	White Shrimp	.0025	.0049	.0128	.0197
1001	108	209	Blue Crab	.0040	.0040	.0020	.0040
1001	108	217	Crabs , Other	.0010	.0010	.0010	.0010
1001	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
1001	108	234	Rock Shrimp	.0013	.0011	.0008	.0011
1001	108	236	Seabob Shrimp	0.0000	0.0000	.0004	.0013
1001	108	298	Other Shrimp	.0016	.0012	.0024	.0099
1001	109	207	Squid	.0083	.0830	.0830	.0083
1002	102	1	Alewife	.0010	.0010	.0010	.0010
1002	102	3	Atlantic Stingray	.0004	.0004	.0004	0.0000
1002	102	3	Gulf Menhaden	.0395	.0395	.0395	.0395
1002	102	5	Gulf Butterfish	.5920	.1050	.0493	.0158
1002	102	33	Spanish Mackerel	.0316	.0316	.0316	.0316
1002	102	42	Scaled Sardine	.0026	.0052	.0043	0.0000
1002	102	43	Atlantic Thread Herring	.0052	.0052	.0052	.0052
1002	102	43	Bay Anchovy	.0043	.0043	.0043	.0043
1002	102	43	Striped Anchovy	.0035	.0035	.0035	.0035
1002	102	44	Striped Mullet	.9700	.9700	.9700	.9700
1002	102	128	Searobins (all)	.0974	.5263	.0658	.0789
1002	102	130	Planehead Filefish	0.0000	.0158	0.0000	0.0000
1002	102	238	Gulf Menhanen	.0658	.0658	.0158	.0158
1002	103			.2000	.2000	0.0000	0.0000
1002	103	8	Bluefish	.4800	.0007	.4800	.8600
1002	103	11	Silver Sea Trout	3.1249	2.4999	2.4999	2.4999
1002	103	11	Weakfish	.0015	.0015	.0015	.0015
1002	103	50	Bonito	.0300	.0300	.0300	.0300
1002	103	51	Jack	.0070	.0070	.0070	.0070
1002	103	52	Amberjack	.030C	.0300	.0300	.0300

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Christi Port & Subzone	Species Category	(Port 10) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1002	103	54	Blue Runner	.0070	.0070	.0070	.0070
1002	103	55	Doulphin	.0030	.0060	.0030	.0030
1002	104	12	Tuna	.0080	.0080	.0080	.0080
1002	104	13	Swordfish	.0280	.0280	.0280	.0280
1002	104	14	Shark	.0100	.0100	.0100	.0100
1002	105			.5000	5.0000	1.0000	1.0000
1002	105	17	Summer Flounder	.0380	.2500	.2100	.2300
1002	105	56	Lefteye Flounders (all)	.3848	.1604	.7697	.3207
1002	105	57	Bay Wiff	0.0000	.1604	.1604	0.0000
1002	105	57	Fringed Flounder	.1604	.1604	.3208	.1604
1002	105	57	Gulf Flounder	0.0000	0.0000	0.0000	0.0000
1002	105	57	Ocellated Flounder	.0535	.0535	.0535	.0535
1002	105	57	Shoal Flounder	.1066	.1066	.1066	.0533
1002	105	237	Lesser Electric Ray	.0004	.0004	.0004	0.0000
1002	105	242	Lined Sole	.1539	.1539	.1539	.1539
1002	106		Silver Perch	.1105	.1105	.1105	.1105
1002	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
1002	106	28	Tilefish	.0390	.0390	.0390	.0390
1002	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
1002	106	34	Harvestfish	.0118	0.0000	.0237	.0985
1002	106	35	Atlantic Croaker	.6154	3.6925	.3077	.2564
1002	106	36	Banded Drum	.2762	.2525	.0789	.0789
1002	106	36	Star Drum	.3552	.2368	.4736	1.7762
1002	106	37	Spot	.2960	.5920	.0592	.1974
1002	106	40	Black Edge Cusk Eel	.0513	.0513	.0513	.0513
1002	106	40	Eels	.0011	.0011	.0011	.0011
1002	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
1002	106	47	Sand Sea Trout	.1499	.9375	2.4999	.2499
1002	106	48	Gafftopsail Catfish	.2130	.2130	.2130	.2130
1002	106	48	Hardhead Catfish	.1065	.3550	2.6641	.0710
1002	106	60	Longspine Porgy	0.0000	.3191	.3191	0.0000
1002	106	60	Porgies	.2000	.2000	.2000	.2000
1002	106	61	Florida Pompano	.0070	.0070	.0011	.0070
1002	106	62	Grunt	.0120	.0120	.0120	.0120
1002	106	63	Pinfish	.1053	.0329	.0329	.5263
1002	106	64	Southern Kingfish	.0789	.0395	.8223	.7890
1002	106	69	Red Snapper	0.0000	.5731	1.1462	0.0000
1002	106	71	Gulf Hake	.0316	.0316	.0316	.0316
1002	106	71	Southern Hake	.0316	0.0000	0.0000	.0316
1002	106	71	Spotted Hake	0.0000	0.0000	0.0000	0.0000
1002	106	76	Black ear Bass	0.0000	.0342	0.0000	.0427
1002	106	76	Rock Sea Bass	.0257	.0427	.0427	.0513
1002	106	76	Sea Bass	.0513	.0342	.0513	.0513
1002	106	77	Gray Triggerfish	.0986	.0986	.0986	.0986
1002	106	131	Rough Scad	.0189	0.0000	0.0000	0.0000
1002	106	132	Singlefoot Frogfish	.0158	.0158	.0158	.0158
1002	106	133	Other Batfish	.0197	.0197	.0197	.0197
1002	106	133	Pancake Batfish	0.0000	0.0000	.0197	.0395
1002	106	134	Inshore Lizardfish	.0631	.0631	.0421	.0316
1002	106	135	Atlantic Medshipmen	.0237	0.0000	.0237	.0158
1002	106	239	Atlantic Bumper	.0474	.0474	.0189	.0095
1002	106	240	Atlantic Moonfish	.3158	.0553	.0189	.0189
1002	106	241	Pigfish	.0329	.0329	.0329	.0658

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Christi Port & Subzone	Species Category	(Port 10) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1002	106	243	Hog Choker	.0974	.0158	.0316	.0316
1002	107			2.0000	20.0000	2.0000	2.0000
1002	108			.0160	.0480	.0160	.0160
1002	108	25	Brown Shrimp	.0493	.0493	.0099	.0025
1002	108	25	Pink Shrimp	.0395	.0025	.0025	.0025
1002	108	25	White Shrimp	.0025	.0049	.0128	.0197
1002	108	209	Blue Crab	.0040	.0040	.0020	.0040
1002	108	217	Crabs , Other	.0010	.0010	.0010	.0010
1002	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
1002	108	234	Rock Shrimp	.0013	.0011	.0008	.0011
1002	108	236	Seabob Shrimp	0.0000	0.0000	.0004	.0013
1002	108	298	Other Shrimp	.0016	.0012	.0024	.0099
1002	109	207	Squid	.0083	.0830	.0830	.0083
1003	102	3	Gulf Menhaden	4.0500	4.0500	1.2000	1.2000
1003	102	33	Spanish Mackerel	.0070	0.0000	.0087	.0094
1003	102	44	Stripped Mullet	4.4500	4.4500	4.4500	4.4500
1003	102	72	Spanish Sardine	.0093	.0006	.0320	.0120
1003	103			.2000	.2000	0.0000	0.0000
1003	103	51	Crevall Jack	.0007	.0070	.0110	.0057
1003	103	54	Blue Runner	.0048	.0047	.0150	.0054
1003	104			.2000	0.0000	0.0000	0.0000
1003	104	75	Barracuda	.0005	.0006	.0027	.0009
1003	105			.5000	5.0000	1.0000	1.0000
1003	105	56	Southern Flounder	.1800	.1800	.1800	.1800
1003	106	35	Atlantic Croaker	1.7490	10.5000	.8750	.8740
1003	106	36	Drum	.5100	.5100	.5100	.5100
1003	106	37	Spot	2.6000	8.4000	8.4000	2.6000
1003	106	45	Sheepshead	.0400	.0400	.0400	.0400
1003	106	46	Spotted Sea Trout	0.0000	.0005	0.0000	0.0000
1003	106	46	Spotted Sea Trout	.6300	.6300	.6300	.6300
1003	106	47	Sand Seatrout	.0900	.1800	.1800	.0900
1003	106	48	Hardhead Catfish	.2800	.2800	.4040	.2800
1003	106	62	Grunts	.0029	.0074	.0036	.0010
1003	106	62	Grunts	.0045	.0005	.0002	.0041
1003	106	62	Gurnts	.0003	.0002	.0002	0.0000
1003	106	63	Pinfish	4.5000	4.5000	1.6800	1.6800
1003	106	68	Grouper	.0029	.0009	.0009	.0012
1003	106	70	Snapper, Other	.0001	.0006	.0006	.0001
1003	106	73	Silver Jenny	.1350	.7000	.0470	.0670
1003	106	74	Bonefish	.0006	.0057	.0048	.0033
1003	106	199	Other Fish	.0120	.0084	.0093	.0093
1003	107			2.0000	20.0000	2.0000	2.0000
1003	107	212	Oyster	103.0000	237.0000	161.0000	161.0000
1003	107	216	Calico Scallops	.0200	.0200	.0200	.0200
1003	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
1003	108			.0160	.0480	.0160	.0160
1003	108	209	Blue Crab	.0360	.1200	.0360	.0080
1003	108	209	Blue Crab	4.1000	4.1000	4.1000	4.1000
1003	108	215	Shrimp - White, Pink, Brn	.9900	1.0500	1.0500	.9900
1003	108	217	Crabs, General	.0040	.0240	.0240	.0040
1003	108	218	Stone Crab	.0240	.0240	.0240	.0240
1003	108	219	Spiny Lobster	.2800	.2800	.2800	.2800

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Christi Port & Subzone	Species Category	(Port 10) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1001	202	1032		5.0000	1.0000	0.0000	0.0000
1001	202	1033		5.0000	5.0000	0.0000	0.0000
1001	202	1043		0.0000	100.0000	100.0000	0.0000
1001	204	1136		1.0000	0.0000	0.0000	0.0000
1001	206	1036		10.0000	10.0000	0.0000	1.0000
1001	206	1120		10.0000	10.0000	10.0000	10.0000
1002	202	1032		5.0000	1.0000	0.0000	0.0000
1002	202	1033		5.0000	5.0000	0.0000	0.0000
1002	202	1043		0.0000	100.0000	100.0000	0.0000
1002	204	1136		1.0000	0.0000	0.0000	0.0000
1002	206	1036		10.0000	10.0000	0.0000	1.0000
1002	206	1120		10.0000	10.0000	10.0000	10.0000
1003	202	1003		.0366	0.0000	.0732	1.2627
1003	202	1043		53.0700	311.1000	2.1960	4.0260
1003	202	1121		.0366	.0092	.0183	0.0000
1003	202	1127		.1281	.0366	.2196	.0366
1003	202	1244		.0549	.0183	0.0000	.0915
1003	205	1242		.2562	.3660	0.0000	0.0000
1003	206	1036		.0275	.0458	0.0000	.0183
1003	206	1046		.2288	.2379	0.0000	0.0000
1003	206	1063		0.0000	0.0000	0.0000	1.0065
1003	206	1073		.0183	0.0000	0.0000	0.0000
1003	206	1073		.4941	2.0130	0.0000	.0092
1003	206	1120		.0092	.1830	.0092	.0183
1003	206	1120		.2013	.4941	.0366	.0732
1003	206	1120		.2745	.0549	.0366	.0732
1003	206	1199		0.0000	0.0000	0.0000	.0366
1003	206	1199		0.0000	0.0000	.0183	0.0000
1003	206	1199		0.0000	.0366	0.0000	0.0000
1003	206	1199		.0183	.0092	.0092	.0366
1003	206	1199		.0915	.4750	0.0000	0.0000
1003	206	1245		.0366	0.0000	0.0000	.0549

APPENDIX J

ZONE 10 - CORPUS CHRISTI, TX

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Corpus Christi		(Port 10)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1001	113		Other Seabirds	2.3000	2.3000	2.3000	2.3000
1002	113		Other Seabirds	2.3000	2.3000	2.3000	2.3000
1003	111	511	American Wigeon	2.3000	0.0000	2.3000	2.3000
1003	111	511	Blue Winged Teal	48.1500	0.0000	48.1500	48.1500
1003	111	511	Gadwall	51.1000	0.0000	51.1000	51.1000
1003	111	511	Green Winged Teal	9.4000	0.0000	9.4000	9.4000
1003	111	511	Mallard	17.5000	0.0000	17.5000	17.5000
1003	111	511	Mottled Duck	8.2000	0.0000	8.2000	8.2000
1003	111	511	Northern Pintail	32.5000	0.0000	32.5000	32.5000
1003	111	511	Nothern Shoveler	6.9500	0.0000	6.9500	6.9500
1003	111	512	American Coot	112.1000	0.0000	112.1000	112.1000
1003	111	515	Bufflehead	.1000	0.0000	.1000	.1000
1003	111	515	Common Goldeneye	.0100	0.0000	.0100	.0100
1003	111	515	Hooded Merganser	.9500	0.0000	.9500	.9500
1003	111	515	Red Breasted Merganser	1.0500	0.0000	1.0500	1.0500
1003	111	515	Ringneck Duck	.0500	0.0000	0.0000	.0500
1003	111	515	Ruddy Duck	.0500	0.0000	0.0000	.0500
1003	111	515	Scaup	.6500	0.0000	.6500	.6500
1003	112		Other Shorebirds	109.0000	43.8000	50.4000	478.0000
1003	112	561	Blk. Crowned Knight Heron	1.0500	1.0500	1.0500	1.0500
1003	112	561	Cattle Egret	.7600	.7600	.7600	.7600
1003	112	561	Great Blue Heron	4.4500	4.4500	4.4500	4.4500
1003	112	561	Great Common Egret	17.6500	17.6500	17.6500	17.6500
1003	112	561	Little Blue Heron	5.2000	5.2000	5.2000	5.2000
1003	112	561	Louisiana Heron	2.0500	2.0500	2.0500	2.0500
1003	112	561	Reddish Egret	.0200	.0200	.0200	.0200
1003	112	561	Snowy Egret	16.0500	16.0500	16.0500	16.0500
1003	112	564	White Faced Ibis	15.9500	15.9500	15.9500	15.9500
1003	112	564	White Ibis	11.6500	11.6500	11.6500	11.6500
1003	113	546	American White Pelican	23.9500	23.9500	23.9500	23.9500
1003	113	546	Brown Pelican	.0100	.0100	.0100	.0100

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NEW YORK CITY, NY

(ZONE 11)

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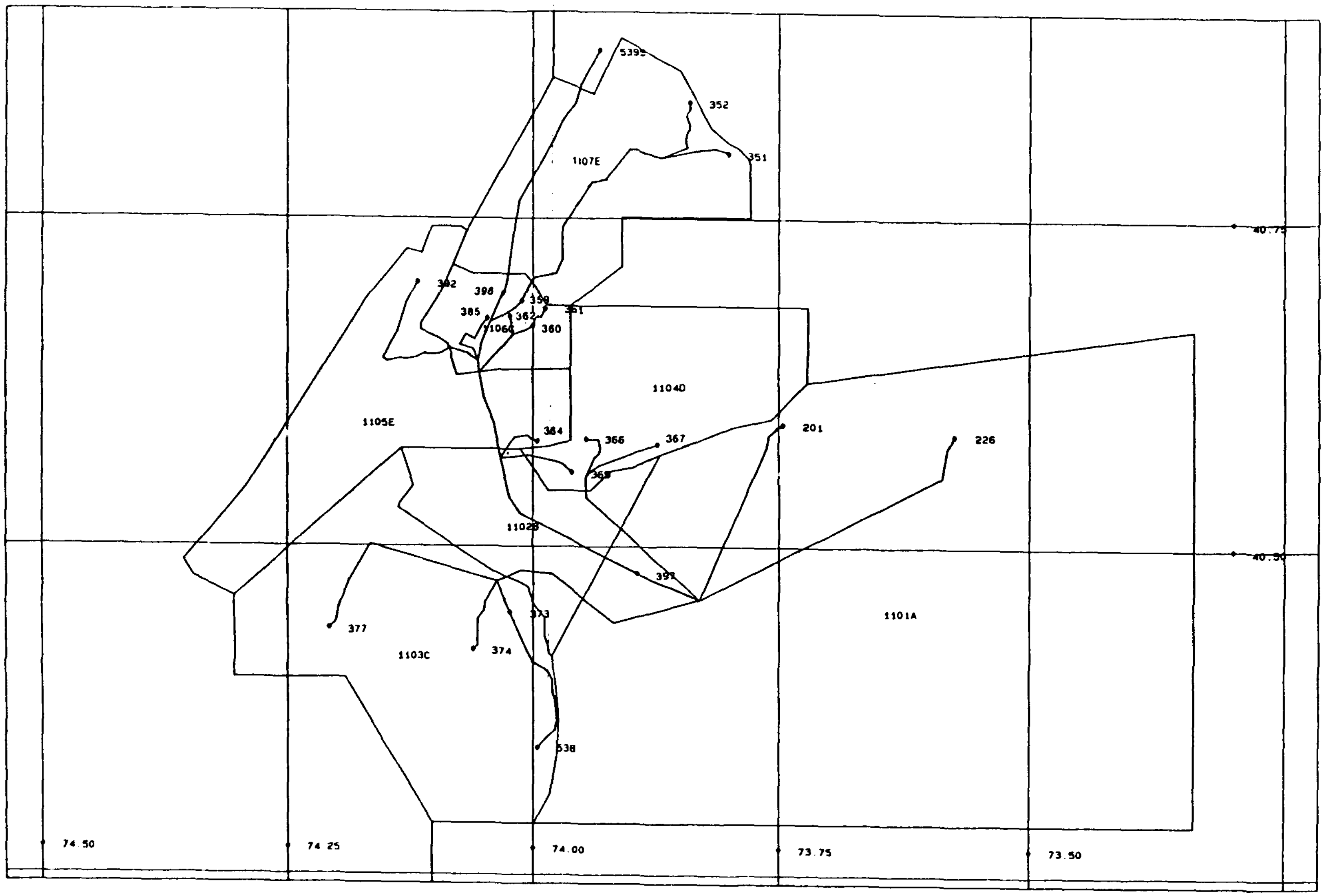
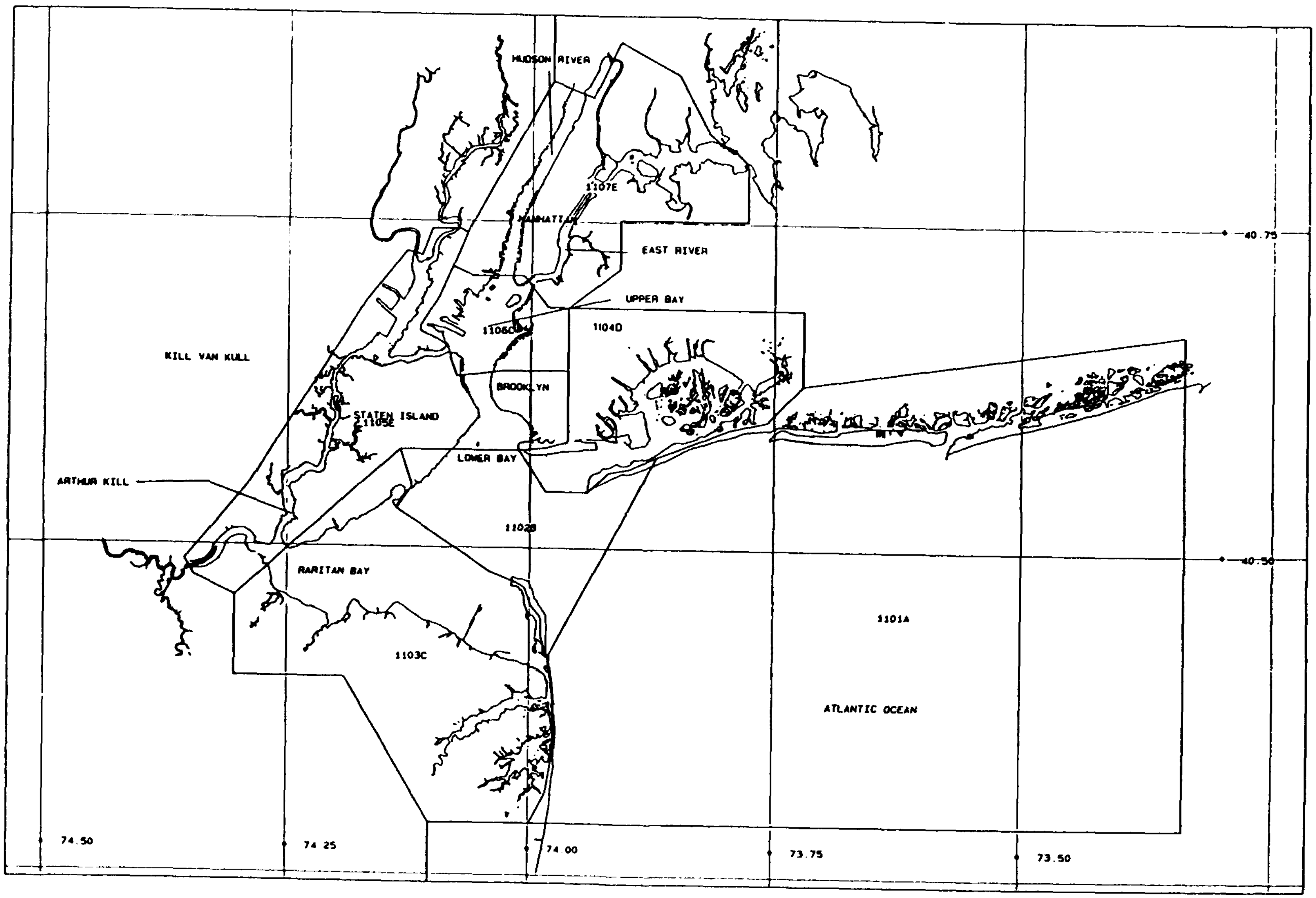
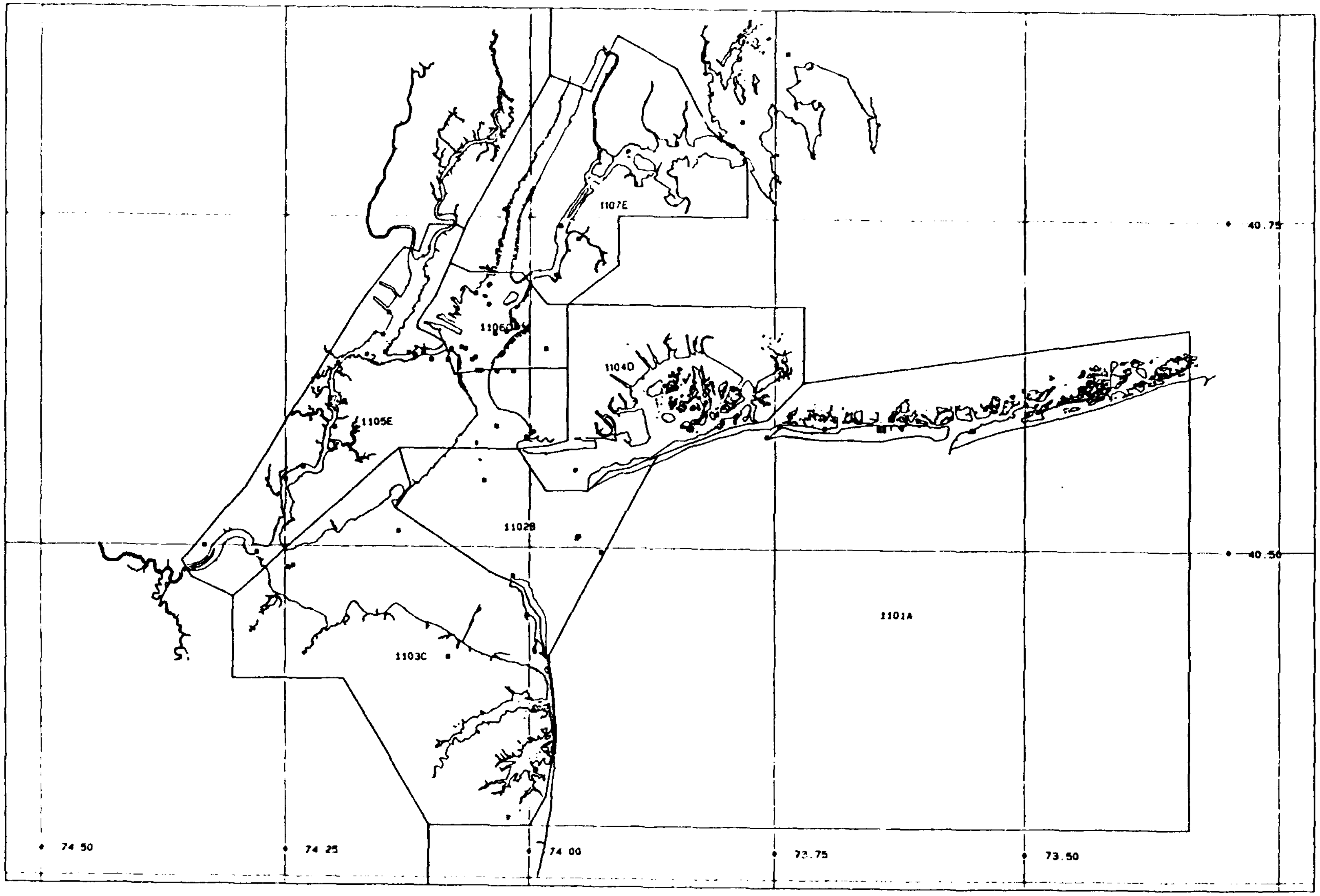


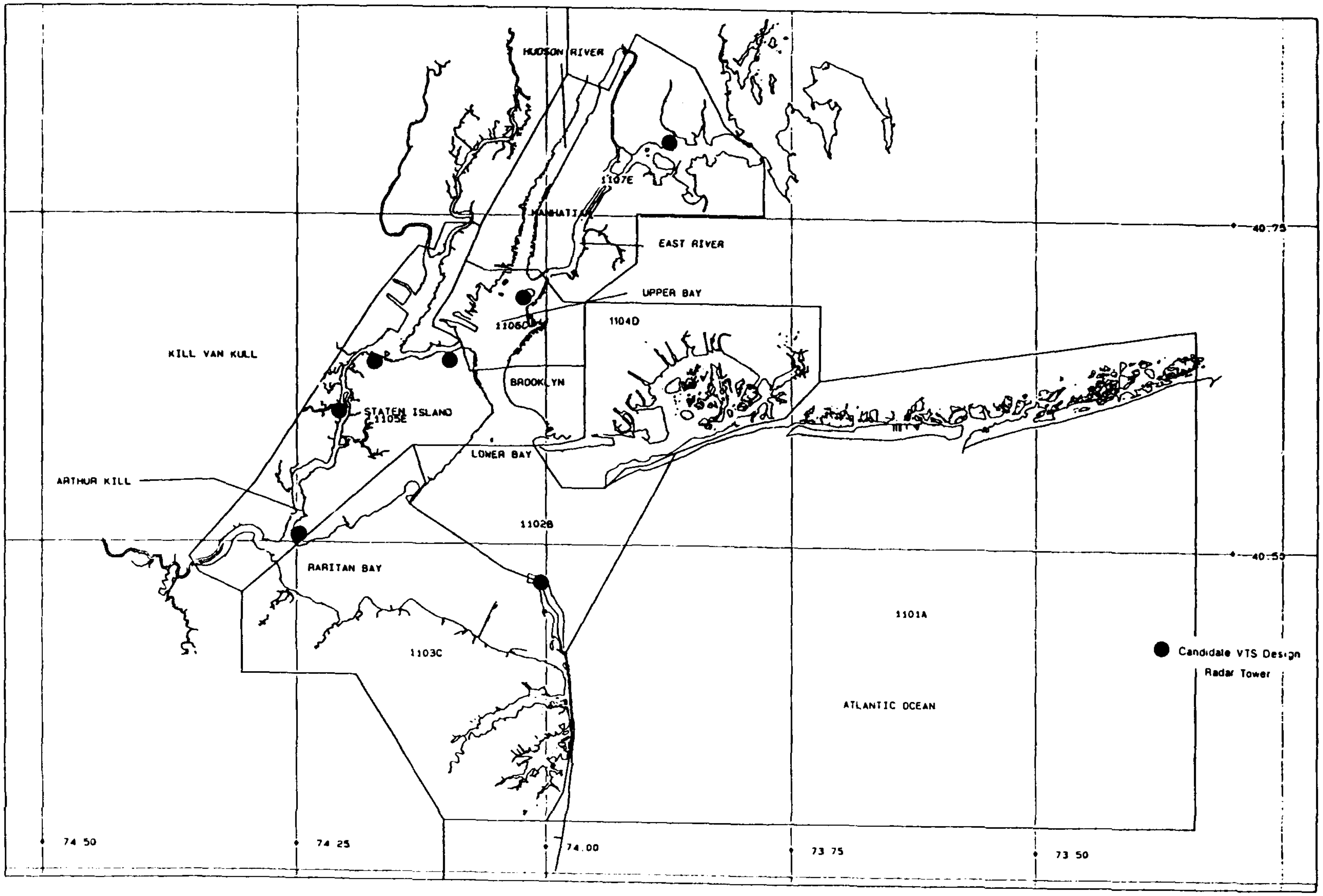
ZONE 11 - NEW YORK CITY, NY - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 11 - NEW YORK CITY, NY - ZONE AND SUBZONE BOUNDARIES



ZONE 11 - NEW YORK CITY, NY - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 11 - NEW YORK CITY, NY - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

NEW YORK CITY, NY

(ZONE 11)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORT OF NEW YORK VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for the Port of New York. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 NEW YORK PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of New York below the tunnel crossing between Manhattan and New Jersey. It includes Port Newark and the New Jersey deep water channels, but excludes the Harlem River and the minor waterways of Brooklyn. The geographic area embraced is about 300 square miles.

The Port of New York is one of the principal ports of the United States and is arguably the largest in terms of the number of facilities. In 1987 the Port handled 96.1 million tons of refined oil, ranking as the No. 1 port in the United States as measured by volume of petroleum products handled (Reference 1). As a matter of interest the next highest ranking port is Houston, with a volume of 29.2 million tons. The heavy emphasis upon petroleum products, and the congestion in the narrow waterways serving petroleum facilities, argues strongly for a Vessel Traffic Service. In addition to normal cargo operations, the New York waterways are important to the transportation of people between the boroughs of New York City, and between the city and suburbs. The Port is also frequently the site of major maritime events such as "Operation Sail," "Fleet Week," and similar activities.

The density of population and water pollution from "no-point", non-marine sources seriously damaged the maritime ecology in and around the Port of New York during the period prior to 1975. Major and sustained efforts have resulted in improvements over the last fifteen years, and there are now concerns that progress could be halted by major ship incidents which result in major spills. The density of habitation and facilities also means that incidents resulting in fire and/or chemical release could result in substantial economic penalty in terms of damaged facilities, disrupted trade and threat to human life.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is predominantly continental rather than maritime, primarily because major weather systems approach the area from the west. As a result New York tends to be hotter in summer than other cities of its latitude and winters are more severe than is the norm for coastal cities. The area averages 28 days per year when the visibility is less than 0.25 mile, with periods of low visibility most prevalent during spring and early summer.

The mean diurnal tidal range is 4.7 feet at Sandy Hook and 4.6 feet at The Battery. Tidal currents tend to be quite strong, with maximum flood velocities in the Lower Bay about two knots. Ebbs are about 10% stronger. Above Governors Island cross currents may be encountered and in Hell Gate, (East River) heavy swirls occur at most tidal stages. At Hell Gate tidal current velocities exceed four knots.

Entrance to the Port from sea is through a series of improved and natural channels. The Project depth for the main deep-draft route (Ambrose Channel-Anchorage Channel) is 45 feet. Project depth for the principal secondary channel, Sandy Hook Channel, is 35 feet to Raritan Bay. Chart tabulations should be consulted for actual dimensions. The Port of New York consists of a series of deep, natural channels which are relatively open and unobstructed, coupled with narrow, improved channels.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S.-flag ships in the coastwise trade with a federally-licensed pilot on board.

Vessels entering from seaward are served by the Sandy Hook Pilots, who maintain a pilot boat on cruising station westward of Ambrose Light. The pilots monitor VHF-FM channels 13, 16 and 73, and use CH73 as a working frequency. Vessels entering via the East River are served by the Hell Gate pilots, who board near Execution Rocks. Hell Gate pilots monitor VHF-FM channels 13, 16 and 18A, using CH18A as a working frequency. Federal pilotage is provided by Interport Pilots Agency, Inc., and meet incoming

ships off Scotland Lighted Horn Buoy S. The Interport Pilot's boat guards VHF-FM channel 16 and works on CH65A.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Off New York Traffic Separation Scheme (TSS)

An "Off New York Traffic Separation Scheme" has been established by 33CFR167.155 to enhance the safety of vessels entering and departing Lower New York. The TSS, with a Precautionary Area centered upon Ambrose Light, meshes with Shipping Safety Fairways leading to the Nantucket TSS. Refer to the Coast Pilot for details (Reference 2).

2.3.2 LaGuardia Airport

Vessels transiting the East River in the vicinity of Rikers Island and using South Brother Island Channel must use care to insure their top hamper does not penetrate the glide path of LaGuardia's northeast-southwest runway. Restrictions are detailed in the Coast Pilot (Reference 3). In addition, a Restricted Area has been established by 33CFR162.20 in Flushing Bay to provide protection for LaGuardia runway 13-31. Within the Restricted Area no vessels having mast heights exceeding 35 feet shall pass through or enter the area when the visibility is less than one mile (Reference 4).

2.3.3 Security Zone

A Security Zone has been established in Sandy Hook Bay around the U. S. Navy Ammunition Depot piers. Within the Zone no vessel may anchor, stop, remain or drift without power. Vessels shall not enter, cross or otherwise navigate within the Security Zone when any vessel which cannot navigate safely outside Terminal Channel is approaching or leaving the Ammunition Depot. No person may swim in the Security Zone, but the Zone may be used by vessels except as discussed above. Consult the Coast Pilot for additional details (Reference 5).

2.3.4 Safety Zone

A Safety Zone has been established for the Sandy Hook Channel, Raritan Bay, Arthur Kill areas. A moving Safety Zone is established for 100 yards around inbound and outbound loaded LPG carriers while transiting between Sandy Hook Channel (Starting at Scotland Lighted Horn Buoy "S") and the receiving facility in Arthur Kill. Refer to the Coast Pilot for details (Reference 6).

2.3.5 Ambrose Channel

Special "Inland Waterways Navigation Regulations" apply to Ambrose Channel, essentially restricting its use to navigation by vessels under efficient control with their own motive power and not having barges or other vessels or floats in tow. Sailing vessels and those having tows are not permitted to use the channel except under permit issued by the U. S. Coast Guard Captain of the Port (COTP), New York. Additional regulations apply and the Coast Pilot should be consulted for details (Reference 7).

2.3.6 Anchorages

The Port of New York area has numerous general and special purpose anchorages. While these are marked with suitable notations on appropriate charts, the Coast Pilot should be consulted for detailed descriptions and restrictions (Reference 8).

2.3.7 Customary Practice

Several customary practices have evolved in recognition of harbor peculiarities.

- In the East River between the Brooklyn Bridge and Poorhouse Flats Range, shallow-draft vessels customarily keep to the west (Manhattan) side of the channel whether north- or southbound. This reserves the east (Brooklyn) side of the channel for deep-draft ships.

- The Battery - St. George (Staten Island) ferries follow a route which keeps them in the extreme right-hand side of the channel.

- Vessels navigating Hell Gate on a flood tide sometimes find it necessary to pass starboard to starboard because of the strong currents between Hallets Point and Negro Point. This is invariably the case when one of the vessels does not maneuver readily or has a tow.

2.3.8 Vessel Traffic Service New York (VTSNY)

The Vessel Traffic Service New York (VTSNY) operates under 33 CFR Part 161. The Regulations published thereunder include a complete description of the VTS area and include General and Special Rules as well as rules for communications and vessel movement reporting.

It is planned to implement the VTSNY in up to three phases. Phase I, implemented on 5 December 1990, provides VTS service in the Upper Bay, Kill Van Kull, and Newark Bay. This area is bounded by the Verrazano Narrows Bridge to the south, the Brooklyn Bridge and Holland Tunnel to the east and north, Kill Van Kull to the AK Rail Bridge, and Newark Bay to the Lehigh Valley (RR) Draw Bridge. Phase II and III, if approved and funded, will extend VTS coverage into the Lower Bay, Arthur Kill, Raritan Bay, and the East River.

The VTSNY functions to collect and process information received from participating vessels, enhanced by CCTV and radar information from remote sensors. Information is then disseminated to shipping about other vessel movements, traffic congestion, weather conditions and other potential hazards to navigation.

The Vessel Traffic Center (VTC), located on Governors Island, monitors vessel traffic movement with radar and closed circuit television (CCTV) located at various places along the waterways, and communicates with "participating" vessels on VHF-FM Channels 14 (primary), 11 and 12. Channel 12 is used for Anchorage Management and Channel 11 is being reserved for use in the future Phase II and III extensions of coverage. The VTC guards Channel 13 (Bridge-to-Bridge), which may be used to communicate with the VTC in emergency. Channel 16 also is guarded by the VTC but participants are not required to guard Channel 16 except when anchored.

While the General Rules of 33CFR161 apply to **all** vessels operating in the VTS area, specific rules for reporting movements and communicating with the VTC apply to certain vessels. These include power driven vessels of 300 gross tons and greater while navigating, vessels of 100 gross tons and greater carrying one or more passengers for hire while navigating, commercial vessels of 26 feet or more in length engaged in towing another vessel, and dredges and floating plants. Thus for vessels falling into one or more of these categories, VTSNY is a **mandatory** system. New York City recently extended VTS participation as a condition for city licensing for certain classes of vessels which otherwise would not qualify.

Participants are required to establish communications with the VTC fifteen minutes before entering the area or getting underway and provide follow-up movement reports at 10 specified locations in the VTS area when the Vessel Movement Reporting System (VMRS) is invoked.

1.	Verrazano Bridge	Upper New York Bay
2.	Brooklyn Bridge	East River
3.	Holland Tunnel Ventilator	Hudson River
4.	Caven Point	Upper New York Bay
5.	Red Hook	Buttermilk Channel
6.	Constable Hook	Kill Van Kull
7.	Bayonne Bridge	Kill Van Kull
8.	AK Rail Bridge	Arthur Kill
9.	Lehigh Valley Draw Bridge	Newark Bay
10.	Texaco Bayonne Facility	Newark Bay

Vessels are required to report when they anchor or moor in, or when they depart from the VTSNY area. Ferries are exempt from the VMRS and must report only when actually underway or docking in the VTS area. Participants **are not** normally notified of ferries they may encounter in their transit (except during periods of low visibility), and are expected to monitor the radio announcements of the ferries as they depart berth. Ferries not operating along normal routes become normal VTS participants.

2.3.9 Existing VTS Technology

VTSNY surveillance is provided by the following:

Governors Island

o Radar on an existing tower provides surveillance of most of the Upper Bay. This is the radar site used in the 1988 system. The radar is a new, modified Raytheon Pathfinder radar presumably similar to the Raytheon radars used in the San Francisco VTS.

o Two CCTV cameras on Castle William provide visual surveillance of the Battery, part of the Upper Bay and the East River to the Brooklyn Bridge.

o Two CCTV cameras atop Building 877 (high-rise apartment building) provide visual surveillance of the Upper Bay, the Hudson River entrance, Red Hook Channel, and part of Buttermilk Channel.

Kill Van Kull (New Brighton)

o Radar (modified Pathfinder) atop roof of existing old Salt Works building (now an Art Center) on Bank Street provides surveillance of Constable Hook Reach and eastern Kill Van Kull. Sector blanking is employed in this radar to suppress radar transmissions over residential land masses. This is a new radar site and was not employed with the 1988 system.

o Two CCTV cameras at the same location provide visual surveillance of the Kill Van Kull waterway.

Mariners Harbor

o Radar (modified Pathfinder) on an existing USCG owned tower (on USCG property) provides surveillance of lower Newark Bay, Shooters Island and western Kill Van Kull. Sector blanking is employed. This radar site was used in the 1988 system.

o Three CCTV cameras on the same tower provide visual surveillance up Newark Bay as well as east and west along the Kill Van Kull waterway.

Radar and CCTV information from the remote sensor sites is carried by microwave relay to *Governors Island*.

The two radars along Kill Van Kull (located at New Brighton and Mariners Harbor) are only 3 nautical miles or so apart. The requirement for two radars in such proximity is driven by the need to have good coverage at the entrance and along Kill Van Kull as well as up into Newark Bay. Experience with the earlier system apparently disclosed blanks in radar coverage along Kill Van Kull from the singular Mariners Harbor site. This problem is probably amplified by the need for sector blanking over populated land masses.

The ship-to-shore voice radio communications system for VTSNY (Phase I) consists of two separate VHF-FM sites; Governors Island and Mariners Harbor. Each site is equipped with Motorola VHF-FM base stations with guard receivers. The equipment is capable of remote control and selection of low power (1-watt) and high power operation. At the present time, all communications are being handled from the Governors Island site on high power until the Mariners Harbor site is fully operational.

VTS participants are directed to initiate communications on low power (1-watt), if available, with higher power being used only of low power communications are unsuccessful or in an emergency. The use of cellular telephone is encouraged as an alternate method of communications in case of radio failure and the

commercial telephone number of the VTC is listed in the VTSNY Users Manual.

VHF-FM Channel 12 is used for anchorage management communications. The VTC acts on behalf of the Captain of the Port to approve or disapprove requests for Federal anchorage use, to direct the movement of vessels anchored outside a designated anchorage area, and/or determine if a technical violation of anchorage regulations occurs. Once anchored, participants are required to resume their own Channel 16 guard requirements (live watch) for the entire time at anchor.

The Vessel Traffic Center (VTC) and its associated equipment are located on Governors Island. The VTC includes sector operating consoles, CCTV monitors, radar monitors, recorders, and ancillary equipment. Any changes in VTC location should consider the top of the high rise apartment building (Bldg. 877) where the critical Upper Bay could be viewed by the VTC.

Sector operators consoles contain control equipment for the VHF-FM radios and CCTV's. Either VHF-FM communications site can be selected for use and each console operator guards 3 or 4 channels.

Sector 1 covers the Upper Bay and the waterways in the vicinity of Governors Island using the radar and CCTV sensors located on Governors Island. Sector 2 covers Constable Hook Reach and eastern Kill Van Kull using radar and CCTV sensors located at New Brighton. Sector 3 covers the remainder of Kill Van Kull and up into Newark Bay using the radar and CCTV sensors located at Mariners Harbor.

Anchorage administration is normally conducted from the Supervisors Console which can view any radar\CCTV sensor and can control both VHF-FM communications sites. During periods of low activity and reduced manning, Sectors operations are combined.

2.3.10 Future VTS Plans

Under Phase II and III, VTSNY would expand its area of coverage to include the Lower Bay, Raritan Bay, Arthur Kill, and the East River to Long Island Sound. Additional radars will probably be included at Sandy Hook with CCTV in Arthur Kill and at Hell Gate. Consideration is being given to radar coverage at Hell Gate and Raritan Bay. Radar and CCTV coverage may be extended along the East River beyond Hell Gate.

2.4 VESSEL TRAFFIC

In 1987, the Port of New York handled 154.5 million tons of cargo. Of this, 10.6 million tons consisted of crude oil and 96.1 million tons were petroleum products (gasoline, jet fuel and heating oil). That same year there were 6027 tank ship movements and 2555 tank barge movements.

The remaining mixed cargo is handled in a variety of vessels, ranging from POST-PANAMAX container ships to barges. Specific statistics for intra-harbor barge movements are poor.

There is heavy ferry traffic between The Battery and Staten Island, and frequent ferry service between Governors Island and the Battery. Passenger-only ferry service is becoming popular as a means of avoiding congested highways, and services exist from various Long Island points to Manhattan. As a general rule, recreational traffic is light in New York Harbor, except for the Lower Bay and the area east of Rikers Island in the approaches from Long Island Sound.

2.5 ENVIRONMENTAL SENSITIVITY

The density of population and water pollution from "no-point", non-marine sources seriously damaged the maritime ecology in and around the Port of New York during the period prior to 1975. Major and sustained efforts have resulted in improvements over the last fifteen years, and there are now concerns that progress could be halted by major ship incidents which result in major spills. The density of habitation and facilities also means that incidents resulting in fire and/or chemical release could result in substantial economic penalty in terms of damaged facilities, disrupted trade and threat to human life.

"Worst case" is undoubtedly a major oil spill involving a tanker and another vessel in or at the entrance to one of the Kills. Such a spill could disrupt traffic, be difficult to contain and clean up because of currents and - if accompanied by fire - endanger shore facilities. A toxic vapor release the plume of which endangers densely populated areas represents the most dangerous type of incident.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 9). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by

a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Seaward Approaches (NOAA Chart 12326)

This sub-zone consists of that portion of the Atlantic Ocean east of 73^0-30'W and south of a line drawn at 40^0-10'N between the shoreline and 73^0-30'W.

The sub-zone functions essentially as a data catchment area for shipping entering the New York VTS Zone from seaward. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is classified as "confined-simple." Confinement is a function of the Traffic Separation Scheme.

2.6.2 Sub-Zone II -- Eastward Approaches (NOAA Charts 12339 & 12366)

This sub-zone consists of that portion of the East River and Long Island Sound between a line between Lawrence Point and Sunken Meadows, and **73^0-44.2'W.**

The sub-zone, with one exception, functions essentially as a data catchment area for shipping entering the New York VTS Zone from the east through Long Island Sound. It corresponds to Sub-Zone II of the Long Island VTS. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements. Traffic using the East River north of Hell Gate should report its intentions 30 minutes prior to entry into the VTS area.

The exception applies to the area in the vicinity of North and South Brothers Island, and Rikers Island. Here there is a channel junction at a point where visibility may be obscured by buildings coupled with a requirement that ships' masts not intrude into the LaGuardia Airport glide path. Some movement management assistance is therefore required.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- New York Entrance (NOAA Chart 12326)

This sub-zone lies inshore of the boundary of Sub-Zone I (73^0-30'W and south of a line drawn at 40^0-10'N between the shoreline and 73^0-30'W) and a line between Rockaway Point Light and Sandy Hook Light.

The sub-zone embraces all of the New York Precautionary Area, the pilot boarding area and the entrances to both Ambrose and Sandy Hook Channels. The VTC should be capable of providing navigational assistance, if required, and movement management advice.

The sub-zone is "confined-complex."

2.6.4 Sub-Zone IV -- Lower New York Bay (NOAA Chart 12327)

This sub-zone consists of all of Lower New York Bay between the inshore boundary of Sub-Zone III (a line between Rockaway Point Light and Sandy Hook Light) and the Verrazano-Narrows Bridge. The sub-zone includes Arthur Kill to the AK Railway Bridge and the Raritan River to the Sandy Point Bridge.

This sub-zone contains the main channel into New York Harbor, Sandy Hook and Swash Channels and a number of narrow river-like channels. It contains busy waterways within which the principal hazards stem from heavy vessel traffic, narrow channels, strong tidal currents, bridge crossings and obscured bends.

The sub-zone is "confined-complex."

2.6.5 Sub-Zone V -- Upper New York Bay (NOAA Chart 12327)

This sub-zone consists of that portion of Upper New York Bay between the inshore boundary of Sub-Zone IV (the Verrazano-Narrows Bridge) to the south, the Brooklyn Bridge and Holland Tunnel to the east and north, Kill Van Kull to the AK railway bridge and Newark Bay to the Lehigh Valley Draw Bridge.

This sub-zone equates to the Phase I NYVTS Area described in 33CFR161. It contains busy waterways within which the principal hazards stem from heavy vessel traffic, narrow channels, strong tidal currents, bridge crossings and obscured bends.

The sub-zone is "confined-complex."

2.6.6 Sub-Zone VI -- East River (NOAA Chart 12327)

This sub-zone consists of the waterways between the Brooklyn Bridge, a line drawn between Lawrence Point and Sunken Meadow and the Wards Island Foot Bridge.

This sub-zone is the primary conduit for tows and other vessels transiting between the Port of New York and Long Island Sound. In general, this is not a difficult waterway and there are few junction points at which significant volumes of traffic join with the flow. With the exception of the confluence area at Hell Gate, where tidal action is extremely strong, the sub-zone is classified as "Confined-simple."

2.6.7 Sub-Zone VII -- Hudson River (NOAA Chart 12327)

This sub-zone consists of the Hudson River north of the Holland Tunnel, and the Harlem River north of the Wards Island Foot Bridge.

The sub-zone functions essentially as a data catchment area for shipping entering the New York VTS Zone from the north via the Hudson River. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-complex."

2.6.8 Sub-Zone VIII -- Passaic & Hackensack Rivers

The sub-zone consists of those portions of the Passaic and Hackensack Rivers above the Lehigh Valley Draw Bridge.

The sub-zone functions essentially as a data catchment area for shipping entering the New York VTS Zone via the Passaic and Hackensack Rivers. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI I-1. Pilots' Cruising Area (NOAA Chart 12326)

This PAI includes the Pilots Cruising Area, where ships take and drop pilots, and the entrances to Ambrose and Sandy Hook Channels. In addition, a General Anchorage lies immediately to the south of the entrance to Sandy Hook Channel. The potential for congestion is high, with the likelihood of random crossings and meetings, necessitating movement management advice. In close weather, navigational assistance should be available.

2.7.2 PAI II-1. North Brothers Island (NOAA Chart 12339)

The South Brothers Island channel intersects the East River near North Brothers Island at a point where approaching vessels may be obscured to view by intervening buildings. Also in this area restrictions apply to ships with mast heights sufficiently tall to intrude into the glide path of one of LaGuardia Airport's runways. Movement management advice may be required.

2.7.3 PAI IV-1. Sandy Hook Junction (NOAA Chart 12327)

West of Sandy Hook Point four channels meet: Sandy Hook Channel, Terminal Channel, Raritan Bay East Reach, and Chapel Hill South Channel. The vicinity of the Junction contains a number of anchorages and, in addition, the bottom is crossed by pipelines and cables. Terminal Channel serves the U. S. Navy Ammunition Depot at Earle, NJ and hence shipping bound to and from that facility normally carries explosives. The potential for congestion is high, with the likelihood of random crossings and meetings, necessitating movement management advice. In close weather, navigational assistance should be available.

2.7.4 PAI IV-2. Swash Channel (NOAA Chart 12327)

Swash Channel is frequently used by tows and shoal-draft vessels. This has the advantage of reducing shoal-draft use of Ambrose and Sandy Hook Channels. The Swash Channel junctions with Chapel Hill North Channel offers the potential for crossing traffic flows and for the merging of southbound Swash Channel traffic with Sandy Hook Channel at a point east of Sandy Hook itself. The potential for congestion is high, with the likelihood of random crossings and meetings, necessitating movement management advice.

Although well marked, Swash Channel may present some navigational difficulties during low visibility. In close weather, navigational assistance should be available.

2.7.5 PAI IV-3. Ambrose and Chapel Hill Junction (NOAA Chart 12327)

The joining of the two channels offers the potential for congestion and movement management advice is required for safety and the smooth flow of traffic.

2.7.6 PAI IV-4. Ward Point (NOAA Chart 12327)

The 180^0 change in the main channel around Ward Point, coupled with its junction with the Raritan River, creates the potential for adverse meetings. Coupled with the number of anchorages in the vicinity of the bend the possibility for significant congestion also exists. Movement management advice and anchorage management are required for safety.

2.7.7 PAI IV-5. Arthur Kill (North End) (NOAA Chart 12333)

The narrowness of the channel, coupled with the volume of traffic and number of facilities, necessitates the capability of providing movement management advice to insure the safe and smooth flow of traffic.

2.7.8 PAI IV-6. Chelsea (NOAA Chart 12331 & 12333)

The narrowness of the channel, coupled with the volume of traffic and number of facilities, necessitates the capability of providing movement management advice to insure the safe and smooth flow of traffic.

2.7.9 PAI V-1. Constable Hook (NOAA Chart 12327)

The entrance into Kill Van Kull from Upper New York Bay is heavily traveled. Ships entering the Kill from the south turn across southbound traffic from the Upper Bay, including the heavy Staten Island-Battery ferry traffic. Vessels outbound from the Kill must cross and/or merge with Upper Bay traffic. Movement management advice is required for smooth and safe traffic flow through this junction point.

2.7.10 PAI V-2. Jersey Flats (NOAA Chart 12327)

The Jersey Flats lie immediately north of the Constable Hook confluence area (PAI-V-1) and is crossed by channels leading to New Jersey terminals. Traffic to and from those terminals cross and merge with the Upper New York Bay flows, including the heavy Staten Island-Battery ferry traffic. Movement management advice is required for smooth and safe traffic flow through this area.

2.7.11 PAI V-3. Red Hook (NOAA Chart 12327)

The area west of Red Hook is the junction of Buttermilk Channel, serving traffic bound from New York Bay to the East River, and the Anchorage Channel of Upper New York Bay. Some percentage of the Buttermilk Channel traffic crosses Anchorage Channel bound to and from Kill Van Kull. Movement management advice is required for smooth and safe traffic flow through this area.

2.7.12 PAI V-4. The Battery (NOAA Chart 12327)

The Battery is a focal point for much of the New York area ferry and cruise boat traffic, and is the point at which one entrance to the East River joins Anchorage Channel. Tidal currents in the area, where the East and Hudson Rivers join Upper New York Bay, are strong. While general traffic tends to avoid this "confluence of ferries" movement management advice should be available to insure smooth and safe transit for those who do not.

2.7.13 PAI V-5. Bergen Point (NOAA Chart 12327)

Bergen Point is the junction point of three channels: Kill Van Kull; North Shooters Reach, leading to Arthur Kill and the west side of Staten Island; and Newark Bay. The junction is combined with a major course change by ships bound to and from Newark Bay. Because of heavy traffic, movement through the junction requires careful management.

2.7.14 PAI V-6. Newark Bay (NOAA Chart 12327)

Newark Bay is subject to congestion from ships making and departing berths in the Port of Newark and barge traffic serving facilities in the Passaic and Hackensack Rivers. Movement management advice is required to insure smooth and safe transits.

2.7.15 PAI VI-1. Hell Gate (NOAA Chart 12339)

Hell Gate is subject to some of the strongest tidal actions on the East Coast of the United States. The junction of the Harlem River with the East River, with its connection between New York Bay and Long Island Sound, gives rise to tidal current velocities which can exceed six knots. The change from ebb to flood occurs rapidly, with strong overfalls and sharp demarkation lines. Underpowered traffic running with the current can experience difficulties in maneuvering, and low powered craft have been known to lose ground against the current. Movement management advice may be required to prevent meetings or overtakings at Hell Gate.

3.0 PORT OF NEW YORK VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of New York is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The eight sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis in Section 2.7. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

TABLE 3-1. NEW YORK CITY, NY PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Seaward Approaches	Data catchment area for inbound shipping	Have knowledge of ship movement, intentions and characteristics. Enter inbound traffic into database.
II	Eastern Approaches	Data catchment area for inbound shipping, channel junction where vision obstructed. Queuing may be required to prevent adverse meetings at Hell Gate.	Have knowledge of vessel movement, intentions and characteristics. Provide movement management advice to vessels in vicinity of N.Brother Island and regulate Hell Gate queue as required.
III	New York Entrance	Potential congestion, merging traffic flows, intersecting channels. Anchorages which require management. Potential navigation problems during low visibility.	Have real-time knowledge of vessel movements and locations. Provide navigational assistance and movement management advice as required. Manage anchorages.
IV	Lower New York Bay	Potential congestion, merging traffic flows, intersecting and narrow channels. Anchorages require management. Potential navigation problems during low visibility. Bridge crossings, obscuring bends.	Same As Above.

TABLE 3-1. NEW YORK CITY, NY PROBLEM AREA IDENTIFIERS (Cont.)

PAI	LOCATION	PROBLEM	MANAGEMENT
V	Upper New York Bay	Potential congestion, merging traffic flows, intersecting and narrow channels. Anchorages require management. Bridge crossings, obscuring bends.	Have real-time knowledge of vessel movements and locations. Provide movement management advice as required. Manage anchorages.
VI	East River	Narrow channels, strong tidal currents, bridge crossings and channel intersections.	Have real-time knowledge of vessel movements, locations. Provide movement management advice as required.
VII	Hudson River	Data catchment area for inbound shipping.	Have knowledge of vessel movement, intentions and characteristics. Enter inbound traffic into database.
VIII	Passaic & Hakensack Rivers	Data catchment area for inbound shipping.	Same As Above.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not

require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the New York VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the overall conclusion that three control sectors managed by three watchstanders is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone II

<u>Hunt's Point Site</u>	1 Module 1 radar 2 Module 10 VHF 1 Module 11 VHF

3.2.2.2 Sub-Zone IV

<u>Sandy Hook Site</u>	1 Module 3 radar 1 Module 11 VHF 1 Module 10 VHF 1 Module 13 MET 1 Module 15 HYD
<u>Tottenville Site</u>	1 Module 1 radar 1 Module 10 VHF
<u>Tremley Point</u>	1 Module 1 radar 1 Module 10 VHF

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone IV
II	1									2	1								Required Radar/Comms coverage from Sub-Zone IV
III																			
IV	2		1							3	1		1		1		2		
V	3						25			3	1		2		1		1		
VI										1									
VII										1		1							
VIII																			

FIGURE 3-1. NEW YORK CITY, NY SURVEILLANCE SURVEY

3.2.2.3 Sub-Zone V

St. George Site	1 Module 1 radar
Mariners Harbor Site	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET
Governor's Island Site	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 15 HYD
Ft. Hamilton Site	1 Module 10 VHF 1 Module 13 MET

3.2.2.4 Sub-Zone VI

Roosevelt Island	1 Module 10 VHF

3.2.2.5 Sub-Zone VII

West NY, NJ Site	1 Module 10 VHF 1 Module 12 MET

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. Three watchstanders and one supervisor with integrated data workstations and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstanders be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located on Governor's Island in a location with good visual surveillance of the Inner Harbor. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The

design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides four operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the New York VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (3 workstations one supervisory console & all software)	2500	
Communications console	200	
Recording Equipment	100	
SCADA Equipment (7 radar sites)	1000	
Sub-total:	3800	1500

Sub-Zone I--Seaward Approaches (NOAA Chart 12326)

Comms coverage from Sub-Zone IV.

Sub-Zone II--Eastern Approaches (NOAA Charts 12339 & 12366)

1 Module 1 radar	310	310
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
Sub-total:	396	356

Sub-Zone III--New York Entrance (NOAA Chart 12326)

Required radar/comms coverage from Sub-Zone IV.

Sub-Zone IV--Lower New York Bay (NOAA Chart 12327)

2 Module 1 radars	620	620
1 Module 3 radar	400	400
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
2 Module 17 CCTV	26	20
Sub-total:	1241	1109

Sub-Zone V--Upper New York Bay (NOAA Chart 12327)

3 Module 1 radars	930	930
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
2 Module 13 MET	40	5
1 Module 15 HYD	50	5
1 Module 17 CCTV	13	10
Sub-total:	1138	1009

Sub-Zone VI--East River (NOAA Chart 12327)

1 Module 10 VHF	19	13
Sub-total:	19	13

Sub-Zone VII--Hudson River (NOAA Chart 12327)

1 Module 10 VHF	19	13
1 Module 12 MET	20	5
Sub-total	39	18
HARDWARE TOTALS:	6633	4005

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$6633
Management, Engineering, etc. (60%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	3980
Installation site integration (25%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	1658
Spares & Training (10%)	663
Civil Engineering 7 remote radar sites, a VTC on Governor's Island many remote comms and WX sensors installations, land acquisition	3000
PROJECT ESTIMATE:	15934
Data Base Management System	300
TOTAL: (non-recurring)	$16234

Recurring (10 year)

Hardware	4005
3 Watchstanders x 5 = 15 man/years @ 50K x 10	7500
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$15505
TOTAL 10-YEAR PROJECT COST:	$31739

Non-government Costs

	Non-recurring	Recurring
25 Module 7 ADS	50	25

REFERENCES

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2. U.S. Coast Pilot, Atlantic Coast: Cape Cod to Sandy Hook, 24th Edition, NOAA, Washington, D.C. 1990.

3. Ibid, p. 194

4. Ibid, p. 57.

5. Ibid, p. 62.

6. Ibid, p. 63.

7. Ibid, p. 58.

8. Ibid, pp. 38-44.

9. Final Report, National Vessel Traffic Services Study, (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: **Intracoastal Waterway**

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

COST SAVINGS DERIVED USING EXISTING SURVEILLANCE EQUIPMENT

NEW YORK (Using 3 Existing USCG Radars)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (3 workstations one supervisory console & all software)	2500	
Communications console	200	
Recording Equipment	100	
SCADA Equipment (7 radar sites)	1000	
Sub-total:	3800	1500

Sub-Zone I--Seaward Approaches (NOAA Chart 12326)

Comms coverage from Sub-Zone IV.

Sub-Zone II--Eastern Approaches (NOAA Charts 12339 & 12366)

1 Module 1 radar	310	310
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
Sub-total:	396	356

Sub-Zone III--New York Entrance (NOAA Chart 12326)

Required radar/comms coverage from Sub-Zone IV.

Sub-Zone IV--Lower New York Bay (NOAA Chart 12327)

2 Module 1 radars	620	620
1 Module 3 radar	400	400
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 15 HYD	50	5
2 Module 17 CCTV	26	20
Sub-total:	1241	1109

New York (Continued)

Sub-Zone V--Upper New York Bay (NOAA Chart 12327)

3 Module 1 radars (existing)		930
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
2 Module 13 MET	40	5
1 Module 15 HYD	50	5
1 Module 17 CCTV	13	10
Sub-total:	208	1009

Sub-Zone VI--East River (NOAA Chart 12327)

1 Module 10 VHF	19	13
Sub-total:	19	13

Sub-Zone VII--Hudson River (NOAA Chart 12327)

1 Module 10 VHF	19	13
1 Module 12 MET	20	5
Sub-total	39	18
HARDWARE TOTALS:	5703	4005

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

Hardware	$5703
Management, Engineering, etc. (55%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	3137
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites 3 radars already installed	1140
Spares & Training (10%) [all 7 radars]	663
Civil Engineering 4 remote radar sites, a VTC on Governor's Island many remote comms and WX sensors installations, some land acquisition	2500
PROJECT ESTIMATE:	13143
Data Base Management System	300
TOTAL: (non-recurring)	$13443

2.2 RECURRING (10 YEAR)

Hardware	4005
3 Watchstanders x 5 = 15 man/years @ 50K x 10	7500
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$15505
TOTAL 10-YEAR PROJECT COST:	$28948

2.3 NON-GOVERNMENT COSTS

	Non-recurring	Recurring
25 Module 7 ADS	50	25

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone IV
II	1									2	1								Required Radar/Comms coverage from Sub-Zone IV
III																			
IV	2	1								3	1		1		1		2		
V							25			3	1		2		1		1		
VI										1									
VII										1		1							

NEW YORK CITY, NY SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix K Zone 11 New York, NY

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1101A		
201	A	EAST ROCKAWAY INLET, N. Y. (DEBS INLET)
226	A	JONES INLET, N. Y.
351	A	EAST RIVER, N. Y.
352	A	WESTCHESTER CREEK, N. Y.
359	A	BUTTERMILK CHANNEL, N. Y.
360	A	GOWANUS CREEK CHANNEL, N. Y.
361	A	GOWANUS CANAL, N. Y.
362	A	BAY RIDGE AND RED HOOK CHANNELS, N. Y.
364	A	CONEY ISLAND CREEK, N. Y.
365	A	CONEY ISLAND CHANNEL, N. Y.
366	A	SHEEPSHEAD BAY, N. Y.
373	A	SANDY HOOK BAY, N. J.
374	A	SANDY HOOK BAY AT LEONARDO, N. J.
377	A	KEYPORT HARBOR, N. J.
385	A	UPPER BAY, NEW YORK HARBOR, N. Y. AND N. J.
392	A	NEWARK BAY, N. J.
396	A	SANDY HOOK CHANNEL, N. Y.
397	A	NEW YORK HARBOR, N. Y. LOWER ENTRANCE CHANNELS
538	A	SHREWSBURY RIVER, N. J.
5395	A	HUDSON RIVER, N. Y. (LOWER SECTION)
Subzone 1102B		
351	A	EAST RIVER, N. Y.
352	A	WESTCHESTER CREEK, N. Y.
359	A	BUTTERMILK CHANNEL, N. Y.
360	A	GOWANUS CREEK CHANNEL, N. Y.
361	A	GOWANUS CANAL, N. Y.
362	A	BAY RIDGE AND RED HOOK CHANNELS, N. Y.
364	A	CONEY ISLAND CREEK, N. Y.
365	A	CONEY ISLAND CHANNEL, N. Y.
366	A	SHEEPSHEAD BAY, N. Y.
367	A	JAMAICA BAY, N. Y.
373	A	SANDY HOOK BAY, N. J.
374	A	SANDY HOOK BAY AT LEONARDO, N. J.
377	A	KEYPORT HARBOR, N. J.
385	A	UPPER BAY, NEW YORK HARBOR, N. Y. AND N. J.
392	A	NEWARK BAY, N. J.
396	A	SANDY HOOK CHANNEL, N. Y.
538	A	SHREWSBURY RIVER, N. J.
5395	A	HUDSON RIVER, N. Y. (LOWER SECTION)
Subzone 1103C		
373	A	SANDY HOOK BAY, N. J.
374	A	SANDY HOOK BAY AT LEONARDO, N. J.
377	A	KEYPORT HARBOR, N. J.
538	A	SHREWSBURY RIVER, N. J.
Subzone 1104D		
365	A	CONEY ISLAND CHANNEL, N. Y.
366	A	SHEEPSHEAD BAY, N. Y.
367	A	JAMAICA BAY, N. Y.
Subzone 1105E		
351	A	EAST RIVER, N. Y.
352	A	WESTCHESTER CREEK, N. Y.
359	A	BUTTERMILK CHANNEL, N. Y.

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/0?/91

COE Waterway		Name
Subzone 1105E		
360	A	GOWANUS CREEK CHANNEL, N. Y.
361	A	GOWANUS CANAL, N. Y.
362	A	BAY RIDGE AND RED HOOK CHANNELS, N. Y.
364	A	CONEY ISLAND CREEK, N. Y.
385	A	UPPER BAY, NEW YORK HARBOR, N. Y. AND N. J.
392	A	NEWARK BAY, N. J.
396	A	SANDY HOOK CHANNEL, N. Y.
5395	A	HUDSON RIVER, N. Y. (LOWER SECTION)
Subzone 1106C		
351	A	EAST RIVER, N. Y.
352	A	WESTCHESTER CREEK, N. Y.
359	A	BUTTERMILK CHANNEL, N. Y.
360	A	GOWANUS CREEK CHANNEL, N. Y.
361	A	GOWANUS CANAL, N. Y.
362	A	BAY RIDGE AND RED HOOK CHANNELS, N. Y.
385	A	UPPER BAY, NEW YORK HARBOR, N. Y. AND N. J.
392	A	NEWARK BAY, N. J.
396	A	SANDY HOOK CHANNEL, N. Y.
5395	A	HUDSON RIVER, N. Y. (LOWER SECTION)
Subzone 1107E		
351	A	EAST RIVER, N. Y.
352	A	WESTCHESTER CREEK, N. Y.
5395	A	HUDSON RIVER, N. Y. (LOWER SECTION)

Appendix K Zone 11 New York, NY 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1101A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,337,191	0	0	0	4,337,191
2	FOREST PRODUCTS	302,001	0	0	0	302,001
3	FISHERIES PRODUCTS	445,906	0	0	0	445,906
4	MINING PRODUCTS, NEC	12,361,143	0	6,258,476	0	18,619,619
5	PROC. FOODS & MFTRS, NEC	57,449,371	0	1,864,420	0	59,313,791
6	WASTE OF MANUFACTURING	7,821,191	0	20,774,973	0	28,596,164
1311	CRUDE PETROLEUM	0	19,365,307	0	1,660,827	21,026,134
1492	SULPHUR, DRY	13,974	0	0	0	13,974
2810	SODIUM HYDROXIDE (CAUSTI	453,470	0	65,244	0	518,714
2811	CRUDE PROD-COAL TAR-PET	216,139	0	0	0	216,139
2813	ALCOHOLS	0	1,525,040	0	55,145	1,580,185
2817	BENZENE AND TOLUENE	0	418,423	0	54,107	472,530
2818	SULPHURIC ACID	5,000	164,228	0	9,324	178,552
2871	NITROGEN CHEM FERTILIZER	5	119,989	0	5,359	125,353
2872	POTASSIC CHEM FERTILIZER	33,936	0	0	0	33,936
2873	PHOSPHA CHEM FERTILIZERS	1,895	0	0	0	1,895
2911	GASOLINE, INCL NATURAL	0	47,695,408	0	21,838,812	69,534,220
2912	JET FUEL	0	3,698,293	0	681,467	4,379,760
2913	KEROSENE	0	960,573	0	730,238	1,690,811
2914	DISTILLATE FUEL OIL	0	23,419,936	0	16,669,774	40,089,710
2915	RESIDUAL FUEL OIL	0	50,047,595	0	16,808,198	66,855,793
2916	LUBRIC OILS-GREASES	0	1,751,945	0	93,969	1,845,914
2917	NAPHTHA, PETRLM SOLVENTS	0	2,740,446	0	227,130	2,967,576
2921	LIQUI PETR-COAL-NATR GAS	9,642	181,430	0	3,448	194,520
	Subzone Total :	83,450,864	152,088,613	28,963,113	58,837,798	323,340,388

Subzone 1102B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,873,433	0	0	0	2,873,433
2	FOREST PRODUCTS	194,016	0	0	0	194,016
3	FISHERIES PRODUCTS	291,201	0	0	0	291,201
4	MINING PRODUCTS, NEC	8,642,054	0	6,409,174	0	15,051,228
5	PROC. FOODS & MFTRS, NEC	36,969,419	0	1,848,962	0	38,818,381
6	WASTE OF MANUFACTURING	4,922,809	0	15,645,730	0	20,568,539
1311	CRUDE PETROLEUM	0	9,810,386	0	1,428,880	11,239,266
1492	SULPHUR, DRY	9,175	0	0	0	9,175
2810	SODIUM HYDROXIDE (CAUSTI	78,354	0	65,244	0	143,598
2811	CRUDE PROD-COAL TAR-PET	102,819	0	0	0	102,819
2813	ALCOHOLS	0	693,024	0	34,948	727,972
2817	BENZENE AND TOLUENE	0	194,905	0	48,681	243,586
2818	SULPHURIC ACID	5,000	105,549	0	7,900	118,449
2871	NITROGEN CHEM FERTILIZER	5	71,681	0	4,186	75,872
2872	POTASSIC CHEM FERTILIZER	22,556	0	0	0	22,556
2873	PHOSPHA CHEM FERTILIZERS	1,260	0	0	0	1,260
2911	GASOLINE, INCL NATURAL	0	33,476,866	0	22,983,546	56,460,412
2912	JET FUEL	0	2,463,313	0	651,552	3,114,865
2913	KEROSENE	0	674,724	0	733,183	1,407,907
2914	DISTILLATE FUEL OIL	0	15,112,281	0	17,000,927	32,113,208
2915	RESIDUAL FUEL OIL	0	28,774,692	0	16,383,268	45,157,960
2916	LUBRIC OILS-GREASES	0	739,203	0	69,384	808,587
2917	NAPHTHA, PETRLM SOLVENTS	0	1,134,147	0	188,137	1,322,284
2921	LIQUI PETR-COAL-NATR GAS	9,642	91,817	0	1,273	102,732
	Subzone Total :	54,121,743	93,342,588	23,969,110	59,535,865	230,969,306

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1103C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	11	0	0	0	11
3	FISHERIES PRODUCTS	99	0	0	0	99
4	MINING PRODUCTS, NEC	60	0	0	0	60
5	PROC. FOODS & MFTRS, NEC	1,869	0	0	0	1,869
6	WASTE OF MANUFACTURING	3,888	0	0	0	3,888
2813	ALCOHOLS	0	19	0	C	19
2914	DISTILLATE FUEL OIL	0	540	0	28,747	29,287
	Subzone Total :	5,927	559	0	28,747	35,233

Subzone 1104D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
4	MINING PRODUCTS, NEC	0	0	301,396	0	301,396
5	PROC. FOODS & MFTRS, NEC	75	0	0	0	75
6	WASTE OF MANUFACTURING	119,822	0	848,976	0	968,798
2911	GASOLINE, INCL NATURAL	0	9,302	0	2,956,755	2,966,057
2913	KEROSENE	0	0	0	19,579	19,579
2914	DISTILLATE FUEL OIL	0	6,931	0	1,047,848	1,054,779
2915	RESIDUAL FUEL OIL	0	0	0	174,399	174,399
	Subzone Total :	119,897	16,233	1,150,372	4,198,581	5,485,083

Subzone 1105E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,873,422	0	0	0	2,873,422
2	FOREST PRODUCTS	194,016	0	0	0	194,016
3	FISHERIES PRODUCTS	291,102	0	0	0	291,102
4	MINING PRODUCTS, NEC	8,641,994	0	6,107,778	0	14,749,772
5	PROC. FOODS & MFTRS, NEC	36,967,475	0	1,848,962	0	38,816,437
6	WASTE OF MANUFACTURING	4,799,099	0	14,796,754	0	19,595,853
1311	CRUDE PETROLEUM	0	9,810,386	0	1,428,880	11,239,266
1492	SULPHUR, DRY	9,175	0	0	0	9,175
2810	SODIUM HYDROXIDE (CAUSTI	78,354	0	65,244	0	143,598
2811	CRUDE PROD-COAL TAR-PET	102,819	0	0	0	102,819
2813	ALCOHOLS	0	693,005	0	34,948	727,953
2817	BENZENE AND TOLUENE	0	194,905	0	48,681	243,586
2818	SULPHURIC ACID	5,000	105,549	0	7,900	118,449
2871	NITROGEN CHEM FERTILIZER	5	71,681	0	4,186	75,872
2872	POTASSIC CHEM FERTILIZER	22,556	0	0	0	22,556
2873	PHOSPHA CHEM FERTILIZERS	1,260	0	0	0	1,260
2911	GASOLINE, INCL NATURAL	0	33,467,564	J	20,026,791	53,494,355
2912	JET FUEL	0	2,463,313	0	651,552	3,114,865
2913	KEROSENE	0	674,724	0	713,604	1,388,328
2914	DISTILLATE FUEL OIL	0	15,104,810	0	15,924,332	31,029,142
2915	RESIDUAL FUEL OIL	0	28,774,692	0	16,208,869	44,983,561
2916	LUBRIC OILS-GREASES	0	739,203	0	69,384	808,587
2917	NAPHTHA, PETRLM SOLVENTS	0	1,134,147	0	188,137	1,322,284
2921	LIQUI PETR-COAL-NATR GAS	9,642	91,817	0	1,273	102,732
	Subzone Total :	53,995,919	93,325,796	22,818,738	55,308,537	225,448,990

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1106C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,873,422	0	0	0	2,873,422
2	FOREST PRODUCTS	194,016	0	0	0	194,016
3	FISHERIES PRODUCTS	291,102	0	0	0	291,102
4	MINING PRODUCTS, NEC	8,641,994	0	6,074,029	0	14,716,023
5	PROC. FOODS & MFTRS, NEC	36,967,475	0	1,848,962	0	38,816,437
6	WASTE OF MANUFACTURING	4,799,099	0	14,796,754	0	19,595,853
1311	CRUDE PETROLEUM	0	9,810,386	0	1,428,880	11,239,266
1492	SULPHUR, DRY	9,175	0	0	0	9,175
2810	SODIUM HYDROXIDE (CAUSTI	78,354	0	65,244	0	143,598
2811	CRUDE PROD-COAL TAR-PET	102,819	0	0	0	102,819
2813	ALCOHOLS	0	693,005	0	34,948	727,953
2817	BENZENE AND TOLUENE	0	194,905	0	48,681	243,586
2818	SULPHURIC ACID	5,000	105,549	0	7,900	118,449
2871	NITROGEN CHEM FERTILIZER	5	71,681	0	4,186	75,872
2872	POTASSIC CHEM FERTILIZER	22,556	0	0	0	22,556
2873	PHOSPHA CHEM FERTILIZERS	1,260	0	0	0	1,260
2911	GASOLINE, INCL NATURAL	0	33,467,564	0	20,026,791	53,494,355
2912	JET FUEL	0	2,463,313	0	651,552	3,114,865
2913	KEROSENE	0	674,724	0	713,604	1,388,328
2914	DISTILLATE FUEL OIL	0	15,104,810	0	15,924,332	31,029,142
2915	RESIDUAL FUEL OIL	0	28,774,692	0	16,208,869	44,983,561
2916	LUBRIC OILS-GREASES	0	739,203	0	69,384	808,587
2917	NAPHTHA, PETRLM SOLVENTS	0	1,134,147	0	188,137	1,322,284
2921	LIQUI PETR-COAL-NATR GAS	9,642	91,817	0	1,273	102,732
	Subzone Total :	53,995,919	93,325,796	22,784,989	55,308,537	225,415,241

Subzone 1107E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	371,420	0	0	0	371,420
2	FOREST PRODUCTS	434	0	0	0	434
3	FISHERIES PRODUCTS	687	0	0	0	687
4	MINING PRODUCTS, NEC	2,664,501	0	3,221,652	0	5,886,153
5	PROC. FOODS & MFTRS, NEC	4,376,832	0	1,207,441	0	5,584,273
6	WASTE OF MANUFACTURING	137,061	0	4,803,588	0	4,940,649
1311	CRUDE PETROLEUM	0	375,249	0	59,208	434,457
2810	SODIUM HYDROXIDE (CAUSTI	13,877	0	0	0	13,877
2813	ALCOHOLS	0	1,022	0	11,012	12,034
2817	BENZENE AND TOLUENE	0	1,099	0	450	1,549
2818	SULPHURIC ACID	0	17,600	0	7,201	24,801
2871	NITROGEN CHEM FERTILIZER	0	9,006	0	0	9,006
2911	GASOLINE, INCL NATURAL	0	8,078,164	0	9,216,839	17,295,003
2912	JET FUEL	0	560,619	0	384,876	945,495
2913	KEROSENE	0	160,015	0	287,758	447,773
2914	DISTILLATE FUEL OIL	0	3,329,906	0	5,891,691	9,221,597
2915	RESIDUAL FUEL OIL	0	4,778,480	0	6,215,558	10,994,038
2916	LUBRIC OILS-GREASES	0	202	0	950	1,152
2917	NAPHTHA, PETRLM SOLVENTS	0	36,654	0	52,830	89,484
2921	LIQUI PETR-COAL-NATR GAS	9,372	189	0	0	9,561
	Subzone Total :	7,574,184	17,348,205	9,232,681	22,128,373	56,283,443

7/22/91

Appendix K ZONE 11 New York, NY

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1101A				
Passenger	0	132	147,573	147,705
Dry Cargo	24,673	7,950	83,822	116,445
Tanker	3,362	1,256	9,293	13,911
Dry Cargo Barge Tow	275	0	7,780	8,055
Tanker Barge Tow	1,538	0	11,377	12,915
Tug/Tow Boat	0	0	62,454	62,454
Subzone Total:	29,848	9,338	322,299	361,485
Subzone : 1102B				
Passenger	0	132	2,668	2,800
Dry Cargo	21,317	3,495	69,717	94,529
Tanker	1,256	255	7,069	8,580
Dry Cargo Barge Tow	122	0	7,740	7,862
Tanker Barge Tow	809	0	10,538	11,347
Tug/Tow Boat	0	0	60,899	60,899
Subzone Total:	23,504	3,882	158,631	186,017
Subzone : 1103C				
Passenger	0	0	2,268	2,268
Dry Cargo	18,479	0	37,013	55,492
Tanker	54	0	71	125
Tanker Barge Tow	7	0	11	18
Tug/Tow Boat	446	0	446	892
Subzone Total:	18,986	0	39,809	58,795
Subzone : 1104D				
Passenger	0	0	200	200
Dry Cargo	0	0	17,564	17,564
Tanker	0	0	2,473	2,473
Dry Cargo Barge Tow	0	0	501	501
Tanker Barge Tow	5	0	2,465	2,470
Tug/Tow Boat	0	0	2,160	2,160
Subzone Total:	5	0	25,363	25,368

Appendix K ZONE 11 New York, NY

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1105E				
Passenger	0	132	3,527	3,659
Dry Cargo	2,838	3,495	15,140	21,473
Tanker	1,202	255	4,525	5,982
Dry Cargo Barge Tow	122	0	7,239	7,361
Tanker Barge Tow	797	0	8,062	8,859
Tug/Tow Boat	0	0	58,293	58,293
Subzone Total:	4,959	3,882	96,786	105,627
Subzone : 1106C				
Passenger	0	132	177,398	177,530
Dry Cargo	2,838	3,495	15,140	21,473
Tanker	1,202	255	4,525	5,982
Dry Cargo Barge Tow	122	0	7,182	7,304
Tanker Barge Tow	797	0	8,062	8,859
Tug/Tow Boat	0	0	58,221	58,221
Subzone Total:	4,959	3,882	270,528	279,369
Subzone : 1107E				
Passenger	0	0	49,918	49,918
Dry Cargo	111	235	11,469	11,815
Tanker	40	15	1,237	1,292
Dry Cargo Barge Tow	24	0	3,355	3,379
Tanker Barge Tow	217	0	2,065	2,282
Tug/Tow Boat	0	0	5,868	5,868
Subzone Total:	392	250	73,912	74,554

Note: Sum of all vessel transits within each study subzone.

Appendix K ZONE 11 New York, NY

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 11 New York, NY

Vessel Type	Large	Medium	Small	Total
Passenger	0	132	354,735	354,867
Dry Cargo	24,673	7,950	83,846	116,469
Tanker	3,362	1,256	10,740	15,358
Dry Cargo Barge Tow	275	0	8,031	8,306
Tanker Barge Tow	1,541	0	12,618	14,159
Tug/Tow Boat	0	0	63,503	63,503
Zone Total:	29,851	9,338	533,473	572,662

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix K Zone 11 New York, NY

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix K Zone 11 New York, NY

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1101A		5,069	7.65
1102B		5,897	90.72
1103C		7,108	88.85
1104D		2,557	71.03
1105E		19,339	166.72
1106C		8,608	573.87
1107E		15,101	686.41
	Total for Zone	63,679	69.89

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

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Appendix K ZONE 11 New York, NY

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1101A				
Passenger	0	135	150,473	150,608
Dry Cargo	34,174	9,780	140,360	184,314
Tanker	3,572	1,319	9,932	14,823
Dry Cargo Tow	0	0	9,048	9,048
Tanker Tow	1,512	0	12,506	14,018
Tug/Tow Boat	0	0	72,613	72,613
Subzone Total:	39,258	11,234	394,932	445,424
Subzone : 1102B				
Passenger	0	135	2,720	2,855
Dry Cargo	30,415	4,711	124,749	159,875
Tanker	1,368	279	7,633	9,280
Dry Cargo Tow	0	0	9,026	9,026
Tanker Tow	746	0	11,720	12,466
Tug/Tow Boat	0	0	70,662	70,662
Subzone Total:	32,529	5,125	226,510	264,164
Subzone : 1103C				
Passenger	0	0	2,313	2,313
Dry Cargo	26,694	0	86,675	113,369
Tanker	66	0	68	134
Tanker Tow	5	0	10	15
Tug/Tow Boat	0	0	1,284	1,284
Subzone Total:	26,765	0	90,350	117,115
Subzone : 1104D				
Passenger	0	0	204	204
Dry Cargo	0	0	19,422	19,422
Tanker	0	0	2,676	2,676
Dry Cargo Tow	0	0	574	574
Tanker Tow	0	0	2,716	2,716
Tug/Tow Boat	0	0	651	651
Subzone Total:	0	0	26,243	26,243

Appendix K ZONE 11 New York, NY

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TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1105E				
Passenger	0	135	3,596	3,731
Dry Cargo	3,721	4,711	18,652	27,084
Tanker	1,302	279	4,889	6,470
Dry Cargo Tow	0	0	8,452	8,452
Tanker Tow	741	0	8,994	9,735
Tug/Tow Boat	0	0	68,727	68,727
Subzone Total:	5,764	5,125	113,310	124,199
Subzone : 1106C				
Passenger	0	135	186,352	186,486
Dry Cargo	3,721	4,711	18,652	27,084
Tanker	1,302	279	4,889	6,470
Dry Cargo Tow	0	0	8,385	8,385
Tanker Tow	741	0	8,994	9,735
Tug/Tow Boat	0	0	68,660	68,660
Subzone Total:	5,764	5,125	295,932	306,820
Subzone : 1107E				
Passenger	0	0	61,096	61,096
Dry Cargo	138	293	13,554	13,985
Tanker	45	17	1,370	1,432
Dry Cargo Tow	0	0	3,920	3,920
Tanker Tow	200	0	2,313	2,513
Tug/Tow Boat	0	0	6,613	6,613
Subzone Total:	383	310	88,866	89,559

Note: Sum of all vessel transits within each study subzone.

Appendix K ZONE 11 New York, NY

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1101A				
Passenger	0	137	153,430	153,568
Dry Cargo	42,910	11,088	157,210	211,208
Tanker	3,823	1,393	10,435	15,651
Dry Cargo Tow	0	0	9,944	9,944
Tanker Tow	1,603	0	13,313	14,916
Tug/Tow Boat	0	0	83,648	83,648
Subzone Total:	48,336	12,618	427,980	488,935
Subzone : 1102B				
Passenger	0	137	2,774	2,911
Dry Cargo	38,854	5,637	140,593	185,084
Tanker	1,471	294	8,000	9,765
Dry Cargo Tow	0	0	9,936	9,936
Tanker Tow	801	0	12,537	13,338
Tug/Tow Boat	0	0	81,588	81,588
Subzone Total:	41,126	6,068	255,428	302,622
Subzone : 1103C				
Passenger	0	0	2,358	2,358
Dry Cargo	34,350	0	98,951	133,301
Tanker	77	0	68	145
Tanker Tow	5	0	11	16
Tug/Tow Boat	0	0	1,650	1,650
Subzone Total:	34,432	0	103,038	137,470
Subzone : 1104D				
Passenger	0	0	208	208
Dry Cargo	0	0	20,670	20,670
Tanker	0	0	2,806	2,806
Dry Cargo Tow	0	0	624	624
Tanker Tow	0	0	2,887	2,887
Tug/Tow Boat	0	0	665	665
Subzone Total:	0	0	27,860	27,860

Appendix K ZONE 11 New York, NY 7/24/91

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1105E				
Passenger	0	137	3,667	3,804
Dry Cargo	4,504	5,637	20,972	31,113
Tanker	1,394	294	5,126	6,814
Dry Cargo Tow	0	0	9,312	9,312
Tanker Tow	796	0	9,639	10,435
Tug/Tow Boat	0	0	79,273	79,273
Subzone Total:	6,694	6,068	127,989	140,751
Subzone : 1106C				
Passenger	0	137	190,014	190,151
Dry Cargo	4,504	5,637	20,972	31,113
Tanker	1,394	294	5,126	6,814
Dry Cargo Tow	0	0	9,238	9,238
Tanker Tow	796	0	9,639	10,435
Tug/Tow Boat	0	0	79,199	79,199
Subzone Total:	6,694	6,068	314,188	326,950
Subzone : 1107E				
Passenger	0	0	62,296	62,296
Dry Cargo	161	338	15,061	15,560
Tanker	48	18	1,466	1,532
Dry Cargo Tow	0	0	4,321	4,321
Tanker Tow	214	0	2,482	2,696
Tug/Tow Boat	0	0	7,528	7,528
Subzone Total:	423	356	93,154	93,933

Note: Sum of all vessel transits within each study subzone.

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Appendix K ZONE 11 New York, NY

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1101A				
Passenger	0	140	157,070	157,211
Dry Cargo	54,564	12,730	186,450	253,744
Tanker	4,095	1,477	11,007	16,579
Dry Cargo Tow	0	0	10,934	10,934
Tanker Tow	1,701	0	14,173	15,874
Tug/Tow Boat	0	0	97,638	97,638
Subzone Total:	60,360	14,347	477,272	551,980
Subzone : 1102B				
Passenger	0	140	2,840	2,980
Dry Cargo	50,176	6,844	168,751	225,771
Tanker	1,581	312	8,407	10,300
Dry Cargo Tow	0	0	10,942	10,942
Tanker Tow	862	0	13,408	14,270
Tug/Tow Boat	0	0	95,459	95,459
Subzone Total:	52,619	7,296	299,807	359,722
Subzone : 1103C				
Passenger	0	0	2,414	2,414
Dry Cargo	44,661	0	122,991	167,652
Tanker	88	0	75	163
Tanker Tow	6	0	11	17
Tug/Tow Boat	0	0	2,143	2,143
Subzone Total:	44,755	0	127,634	172,389
Subzone : 1104D				
Passenger	0	0	213	213
Dry Cargo	0	0	22,011	22,011
Tanker	0	0	2,942	2,942
Dry Cargo Tow	0	0	680	680
Tanker Tow	0	0	3,065	3,065
Tug/Tow Boat	0	0	680	680
Subzone Total:	0	0	29,591	29,591

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Appendix K ZONE 11 New York, NY

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1105E				
Passenger	0	140	3,754	3,894
Dry Cargo	5,515	6,844	23,749	36,108
Tanker	1,493	312	5,390	7,195
Dry Cargo Tow	0	0	10,262	10,262
Tanker Tow	856	0	10,332	11,188
Tug/Tow Boat	0	0	92,636	92,636
Subzone Total:	7,864	7,296	146,123	161,283
Subzone : 1106C				
Passenger	0	140	194,522	194,662
Dry Cargo	5,515	6,844	23,749	36,108
Tanker	1,493	312	5,390	7,195
Dry Cargo Tow	0	0	10,181	10,181
Tanker Tow	856	0	10,332	11,188
Tug/Tow Boat	0	0	92,555	92,555
Subzone Total:	7,864	7,296	336,729	351,889
Subzone : 1107E				
Passenger	0	0	63,774	63,774
Dry Cargo	188	394	16,787	17,369
Tanker	51	19	1,569	1,639
Dry Cargo Tow	0	0	4,765	4,765
Tanker Tow	230	0	2,664	2,894
Tug/Tow Boat	0	0	8,642	8,642
Subzone Total:	469	413	98,201	99,083

Note: Sum of all vessel transits within each study subzone.

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Appendix K ZONE 11 New York, NY

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1101A				
Passenger	0	144	160,796	160,940
Dry Cargo	70,278	14,798	228,205	313,281
Tanker	4,419	1,577	11,648	17,644
Dry Cargo Tow	0	0	12,019	12,019
Tanker Tow	1,811	0	15,106	16,917
Tug/Tow Boat	0	0	115,630	115,630
Subzone Total:	76,508	16,519	543,404	636,431
Subzone : 1102B				
Passenger	0	144	2,907	3,051
Dry Cargo	65,512	8,417	209,328	283,257
Tanker	1,709	331	8,843	10,883
Dry Cargo Tow	0	0	12,046	12,046
Tanker Tow	928	0	14,347	15,275
Tug/Tow Boat	0	0	113,317	113,317
Subzone Total:	68,149	8,892	360,788	437,829
Subzone : 1103C				
Passenger	0	0	2,471	2,471
Dry Cargo	58,670	0	158,807	217,477
Tanker	101	0	81	182
Tanker Tow	7	0	13	20
Tug/Tow Boat	0	0	2,814	2,814
Subzone Total:	58,778	0	164,186	222,964
Subzone : 1104D				
Passenger	0	0	218	218
Dry Cargo	0	0	23,461	23,461
Tanker	0	0	3,086	3,086
Dry Cargo Tow	0	0	741	741
Tanker Tow	0	0	3,256	3,256
Tug/Tow Boat	0	0	695	695
Subzone Total:	0	0	31,457	31,457

Appendix K ZONE 11 New York, NY

7/24/91

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1105E				
Passenger	0	144	3,843	3,987
Dry Cargo	6,842	8,417	27,060	42,319
Tanker	1,608	331	5,676	7,615
Dry Cargo Tow	0	0	11,305	11,305
Tanker Tow	921	0	11,078	11,999
Tug/Tow Boat	0	0	109,808	109,808
Subzone Total:	9,371	8,892	168,770	187,033
Subzone : 1106C				
Passenger	0	144	199,136	199,280
Dry Cargo	6,842	8,417	27,060	42,319
Tanker	1,608	331	5,676	7,615
Dry Cargo Tow	0	0	11,215	11,215
Tanker Tow	921	0	11,078	11,999
Tug/Tow Boat	0	0	109,718	109,718
Subzone Total:	9,371	8,892	363,883	382,146
Subzone : 1107E				
Passenger	0	0	65,287	65,287
Dry Cargo	224	464	18,766	19,454
Tanker	55	21	1,679	1,755
Dry Cargo Tow	0	0	5,252	5,252
Tanker Tow	247	0	2,860	3,107
Tug/Tow Boat	0	0	10,021	10,021
Subzone Total:	526	485	103,865	104,876

Note: Sum of all vessel transits within each study subzone.

Appendix K ZONE 11 New York, NY

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	135	361,706	361,841
Dry Cargo	30,766	9,004	132,597	172,367
Tanker	3,572	1,319	11,499	16,390
Dry Cargo Tow	0	0	9,342	9,342
Tanker Tow	1,512	0	13,896	15,408
Tug/Tow Boat	0	0	72,613	72,613
1995 Zone Total:	35,850	10,458	601,653	647,961
2000 FORECASTED ZONE TOTALS				
Passenger	0	137	368,815	368,952
Dry Cargo	36,149	9,703	142,875	188,727
Tanker	3,823	1,393	12,079	17,295
Dry Cargo Tow	0	0	10,268	10,268
Tanker Tow	1,603	0	14,806	16,409
Tug/Tow Boat	0	0	83,647	83,647
2000 Zone Total:	41,575	11,233	632,490	685,298
2005 FORECASTED ZONE TOTALS				
Passenger	0	140	377,564	377,705
Dry Cargo	45,931	10,843	164,629	221,403
Tanker	4,095	1,477	12,732	18,304
Dry Cargo Tow	0	0	11,291	11,291
Tanker Tow	1,701	0	15,775	17,476
Tug/Tow Boat	0	0	97,638	97,638
2005 Zone Total:	51,727	12,460	679,629	743,817
2010 FORECASTED ZONE TOTALS				
Passenger	0	144	386,521	386,664
Dry Cargo	59,110	12,599	199,153	270.862
Tanker	4,419	1,577	13,458	19,454
Dry Cargo Tow	0	0	12,413	12,413
Tanker Tow	1,811	0	16,826	18,637
Tug/Tow Boat	0	0	115,630	115,630
2010 Zone Total:	65,340	14,320	744,001	823,660

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix K Zone 11 New York, NY 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1101A						
Passenger	Small	0	1	0	0	1
Tanker	Small	0	0	3	0	3
Tanker Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	1	4	0	5
Subzone: 1102B						
Passenger	Small	2	0	0	0	2
Dry Cargo	Large	0	0	2	0	2
Dry Cargo	Medium	0	0	1	0	1
Tanker	Large	0	0	2	0	2
Tug/Tow Boat	Small	0	0	4	0	4
Subzone Totals:		2	0	9	0	11
Subzone: 1103C						
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	0	0	2	0	2
Tanker Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	0	4	0	4
Subzone: 1104D						
Dry Cargo Barge Tow	Small	0	1	0	0	1
Tanker Barge Tow	Small	0	0	1	0	1
Tug/Tow Boat	Small	0	0	1	0	1
Subzone Totals:		0	1	2	0	3
Subzone: 1105E						
Dry Cargo	Large	1	4	1	0	6
Dry Cargo	Medium	1	1	0	0	2
Tanker	Large	0	1	1	0	2
Tanker	Medium	0	0	1	0	1
Tanker	Small	2	0	0	0	2
Dry Cargo Barge Tow	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	2	1	0	4
Tanker Barge Tow	Large	0	1	1	0	2
Tanker Barge Tow	Small	6	1	3	0	10
Tug/Tow Boat	Small	3	2	0	0	5
Other	Small	2	0	0	0	2
Subzone Totals:		16	12	9	0	37

Note: OTHER equals barge breakaways and weather caused vessel casualties.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1106C						
Passenger	Small	1	0	1	0	2
Dry Cargo	Large	1	1	0	0	2
Dry Cargo	Medium	0	1	0	0	1
Tanker	Large	0	0	2	0	2
Dry Cargo Barge Tow	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	2	0	2
Other	Small	1	0	1	0	2
Subzone Totals:		3	2	7	0	12
Subzone: 1107E						
Dry Cargo	Small	2	0	0	0	2
Dry Cargo Barge Tow	Small	2	2	0	0	4
Tanker Barge Tow	Small	2	0	2	0	4
Tug/Tow Boat	Small	0	0	1	0	1
Subzone Totals:		6	2	3	0	11
Zone Totals:		27	18	38	0	83

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE K-8 ZONE 11, NEW YORK CITY, NY - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
1101A																	III
1102B	II	II					II	II	II	II		II					III
1103C	II	II					II	II	II	II		II					III
1104D																	I
1105E	II	II					II	II	II	II		II					III
1106C	II	II					II	II	II	II		II					III
1107E	I	I					I	I	I	I		I					III

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

APPENDIX TABLE K-9 ZONE 11, NEW YORK CITY, NY
CANDIDATE VTS DESIGN - 1995-2010

UNITS

3	Radar Module 1	- Average Performance
1	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
25	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
10	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
3	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
2	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
3	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix K Zone 11 New York, NY

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.21	0.00	.24	.45
Passenger	Small	2.43	.39	2.88	5.71
Dry Cargo	Large	7.79	1.46	12.48	21.73
Dry Cargo	Medium	1.65	.26	.69	2.60
Dry Cargo	Small	4.83	.59	1.01	6.43
Tanker	Large	2.20	.51	3.23	5.94
Tanker	Medium	.06	.01	.04	.11
Tanker	Small	.50	0.00	.40	.90
Dry Cargo Barge T	Small	6.27	1.90	2.45	10.62
Tanker Barge Tow	Large	.41	.19	.28	.88
Tanker Barge Tow	Small	6.48	1.15	4.38	12.02
Tug/Tow Boat	Small	5.70	1.96	4.27	11.92
		38.55	8.42	32.34	79.31

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	371	0	258	629
Passenger	Small	2,012	307	1,740	4,058
Dry Cargo	Large	10,846	2,549	3,926	17,321
Dry Cargo	Medium	2,527	491	207	3,226
Dry Cargo	Small	3,311	395	611	4,317
Tanker	Large	13,616	3,264	11,286	28,166
Tanker	Medium	110	12	29	150
Tanker	Small	298	0	93	392
Dry Cargo Barge T	Small	337	236	35	608
Tanker Barge Tow	Large	4,693	2,170	1,942	8,805
Tanker Barge Tow	Small	15,403	2,796	1,209	19,407
Tug/Tow Boat	Small	437	266	305	1,009
		53,962	12,486	21,642	88,089

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places.
Counts totals were calculated before rounding.

TABLE 10B

Avoided Vessel Casualties 1996 - 2010
Existing VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.16	0.00	.20	.36
Passenger	Small	1.20	.27	1.68	3.16
Dry Cargo	Large	5.06	1.12	8.86	15.04
Dry Cargo	Medium	1.18	.23	.54	1.95
Dry Cargo	Small	2.86	.44	.66	3.96
Tanker	Large	1.53	.43	2.46	4.41
Tanker	Medium	.04	.00	.03	.07
Tanker	Small	.33	0.00	.29	.62
Dry Cargo Barge T	Small	4.13	1.56	1.78	7.47
Tanker Barge Tow	Large	.28	.16	.21	.65
Tanker Barge Tow	Small	4.45	.96	3.31	8.72
Tug/Tow Boat	Small	4.25	1.74	3.49	9.48
		25.47	6.91	23.51	55.89

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	277	0	216	493
Passenger	Small	1,044	218	1,043	2,305
Dry Cargo	Large	6,960	1,924	2,726	11,610
Dry Cargo	Medium	1,815	444	164	2,423
Dry Cargo	Small	1,897	294	404	2,595
Tanker	Large	9,364	2,706	8,377	20,447
Tanker	Medium	71	9	19	99
Tanker	Small	196	0	68	264
Dry Cargo Barge T	Small	226	193	28	447
Tanker Barge Tow	Large	3,322	1,917	1,585	6,824
Tanker Barge Tow	Small	11,215	2,477	978	14,670
Tug/Tow Boat	Small	327	232	207	767
		36,715	10,415	15,814	62,945

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.03	0.00	.03	.06
Passenger	Small	.15	.02	.18	.35
Dry Cargo	Large	.98	.18	1.56	2.73
Dry Cargo	Medium	.21	.03	.09	.32
Dry Cargo	Small	.31	.04	.06	.41
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.02
Tanker Barge Tow	Small	.01	.00	.01	.03
Tug/Tow Boat	Small	.01	.00	.01	.03
Totals		1.71	.29	1.95	3.94
Candidate VTS Design - Dollars					
Passenger	Medium	39,411.63	0.00	44,497.86	83,909.49
Passenger	Small	220,776.35	35,423.21	266,595.72	522,795.29
Dry Cargo	Large	1,465,575.36	274,826.97	2,347,308.54	4,087,710.88
Dry Cargo	Medium	308,431.39	47,440.91	128,116.39	483,988.69
Dry Cargo	Small	463,528.26	55,971.21	95,847.42	615,346.88
Tanker	Small	1,589.25	0.00	1,290.92	2,880.17
Dry Cargo Barge Tow	Small	20,724.23	5,861.75	7,121.63	33,707.60
Tanker Barge Tow	Small	21,430.79	3,795.20	14,277.01	39,503.00
Tug/Tow Boat	Small	18,829.75	6,481.89	14,102.63	39,414.27
Totals		2,560,297.01	429,801.14	2,919,158.13	5,909,256.27
Existing VTS Design - Counts					
Passenger	Medium	.02	0.00	.03	.04
Passenger	Small	.08	.02	.11	.20
Dry Cargo	Large	.62	.13	1.08	1.83
Dry Cargo	Medium	.15	.03	.07	.24
Dry Cargo	Small	.18	.03	.04	.25
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.00	.00	.02
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.01	.00	.01	.02
Totals		1.07	.21	1.34	2.62
Existing VTS Design - Dollars					
Passenger	Medium	29,527.47	0.00	37,602.97	67,130.44
Passenger	Small	115,137.39	26,302.29	161,504.79	302,944.48
Dry Cargo	Large	932,222.50	195,829.88	1,618,914.82	2,746,967.19
Dry Cargo	Medium	221,253.82	42,767.59	100,937.35	364,958.75
Dry Cargo	Small	264,742.57	41,420.94	63,556.02	369,719.53
Tanker	Small	1,095.46	0.00	963.57	2,059.03
Dry Cargo Barge Tow	Small	12,269.19	4,658.78	5,853.74	22,781.71
Tanker Barge Tow	Small	14,725.99	3,174.13	10,937.00	28,837.12
Tug/Tow Boat	Small	14,040.85	5,176.54	9,558.74	28,776.13
Totals		1,605,015.24	319,330.15	2,009,829.01	3,934,174.39

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.01
Passenger	Small	1.75	.29	2.07	4.10
Dry Cargo	Large	.11	.02	.17	.29
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	3.66	.44	.76	4.86
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	.15	.04	.05	.24
Tanker Barge Tow	Small	.16	.03	.10	.29
Tug/Tow Boat	Small	.14	.05	.10	.29
Totals		5.99	.87	3.27	10.14
Candidate VTS Design - Dollars					
Passenger	Medium	675.41	0.00	764.00	1,439.42
Passenger	Small	415,767.76	67,887.18	492,185.49	975,840.43
Dry Cargo	Large	25,154.78	4,718.34	39,671.93	69,545.05
Dry Cargo	Medium	5,278.26	811.42	2,212.80	8,302.48
Dry Cargo	Small	872,935.25	105,416.32	180,512.33	1,158,863.89
Tanker	Small	2,776.92	0.00	2,306.58	5,083.50
Dry Cargo Barge Tow	Small	35,244.53	10,313.76	12,443.52	58,001.81
Tanker Barge Tow	Small	37,455.76	6,631.40	24,946.42	69,033.57
Tug/Tow Boat	Small	32,901.49	11,325.66	24,641.72	68,868.88
Totals		1,428,190.16	207,104.08	779,684.79	2,414,979.03
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.91	.21	1.28	2.39
Dry Cargo	Large	.07	.01	.12	.20
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	2.09	.33	.50	2.92
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	.10	.03	.04	.18
Tanker Barge Tow	Small	.11	.02	.08	.21
Tug/Tow Boat	Small	.10	.04	.07	.21
Totals		3.40	.65	2.10	6.16
Existing VTS Design - Dollars					
Passenger	Medium	506.98	0.00	645.63	1,152.61
Passenger	Small	216,861.89	49,539.09	303,984.24	570,385.22
Dry Cargo	Large	16,006.02	3,518.13	27,266.32	46,790.47
Dry Cargo	Medium	3,798.87	732.39	1,738.50	6,269.76
Dry Cargo	Small	495,878.97	77,996.31	119,677.03	693,552.32
Tanker	Small	1,914.11	0.00	1,683.66	3,597.77
Dry Cargo Barge Tow	Small	23,067.15	8,097.78	10,227.95	41,392.88
Tanker Barge Tow	Small	25,730.94	5,546.20	19,110.38	50,387.51
Tug/Tow Boat	Small	24,533.81	9,041.64	16,947.01	50,522.46
Totals		808,298.74	154,471.54	501,280.72	1,464,051.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.16	0.00	.10	.26
Passenger	Small	1.95	.25	.89	3.09
Dry Cargo	Large	5.77	1.04	1.22	8.02
Dry Cargo	Medium	1.22	.18	.07	1.46
Dry Cargo	Small	4.14	.41	.53	5.07
Tanker	Large	1.66	.41	.42	2.49
Tanker	Medium	.05	.00	.01	.06
Tanker	Small	.11	0.00	.09	.20
Dry Cargo Barge Tow	Small	4.61	.75	.31	5.67
Tanker Barge Tow	Large	.37	.09	.05	.52
Tanker Barge Tow	Small	4.95	.49	.60	6.03
Tug/Tow Boat	Small	1.00	.22	.53	1.76
Totals		25.98	3.84	4.82	34.63
Candidate VTS Design - Dollars					
Passenger	Medium	135,585.99	0.00	88,752.31	224,338.31
Passenger	Small	655,795.52	85,928.74	455,605.06	1,197,329.32
Dry Cargo	Large	4,209,725.59	764,450.17	722,852.16	5,697,027.91
Dry Cargo	Medium	1,083,034.27	159,442.22	29,497.27	1,271,973.76
Dry Cargo	Small	785,680.13	77,041.09	135,210.07	997,931.29
Tanker	Large	1,305,201.17	322,140.08	911,322.86	2,538,664.10
Tanker	Medium	30,838.29	3,115.23	9,634.91	43,588.42
Tanker	Small	32,755.75	0.00	34,422.99	67,178.73
Dry Cargo Barge Tow	Small	267,870.03	43,382.50	15,787.27	327,039.81
Tanker Barge Tow	Large	60,864.49	15,404.36	10,870.90	87,139.75
Tanker Barge Tow	Small	350,958.46	34,418.99	54,277.24	439,654.69
Tug/Tow Boat	Small	71,792.69	15,885.08	52,323.11	140,000.87
Totals		8,990,102.37	1,521,208.45	2,520,556.15	13,031,866.96
Existing VTS Design - Counts					
Passenger	Medium	.12	0.00	.09	.20
Passenger	Small	1.02	.18	.53	1.73
Dry Cargo	Large	3.67	.76	.84	5.28
Dry Cargo	Medium	.87	.16	.05	1.08
Dry Cargo	Small	2.32	.30	.34	2.95
Tanker	Large	1.16	.34	.32	1.82
Tanker	Medium	.03	.00	.00	.04
Tanker	Small	.07	0.00	.06	.14
Dry Cargo Barge Tow	Small	3.13	.62	.24	3.99
Tanker Barge Tow	Large	.26	.08	.04	.38
Tanker Barge Tow	Small	3.40	.41	.46	4.27
Tug/Tow Boat	Small	.75	.18	.38	1.31
Totals		16.80	3.03	3.36	23.19
Existing VTS Design - Dollars					
Passenger	Medium	101,581.98	0.00	75,113.86	176,695.83
Passenger	Small	348,334.43	62,208.91	270,854.07	681,397.41
Dry Cargo	Large	2,709,558.85	573,421.58	503,398.52	3,786,378.95
Dry Cargo	Medium	773,129.91	142,542.28	23,239.62	938,911.81
Dry Cargo	Small	440,176.44	56,512.29	86,967.43	583,656.16
Tanker	Large	908,077.95	267,696.90	694,514.92	1,870,289.77
Tanker	Medium	19,892.35	2,379.60	6,645.67	28,917.62
Tanker	Small	21,710.03	0.00	24,908.44	46,618.47
Dry Cargo Barge Tow	Small	181,770.31	35,847.31	12,226.94	229,844.56
Tanker Barge Tow	Large	41,696.14	13,072.03	8,342.76	63,110.93
Tanker Barge Tow	Small	241,123.99	28,778.77	41,579.46	311,482.22
Tug/Tow Boat	Small	53,573.60	12,666.71	37,464.84	103,705.15
Totals		5,840,625.98	1,195,126.38	1,785,256.53	8,821,008.89

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 **Avoided Cargo Damage/Loss 1996 - 2010**

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.04	0.00	.02	.06
Passenger	Small	.52	.07	.24	.83
Dry Cargo	Large	2.37	.56	1.59	4.52
Dry Cargo	Medium	.50	.10	.09	.68
Dry Cargo	Small	1.88	.21	.23	2.32
Tanker	Large	.68	.16	.43	1.27
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.13	0.00	.06	.19
Dry Cargo Tow	Small	1.23	.38	.20	1.81
Tanker Tow	Large	.05	.02	.03	.10
Tanker Tow	Small	1.37	.24	.37	1.98
Tug/Tow Boat	Small	.49	.14	.15	.78
Totals		9.27	1.89	3.41	14.56
Candidate VTS Design - Dollars					
Passenger	Medium	596.48	0.00	276.65	873.13
Passenger	Small	1,689.15	217.33	989.54	2,896.02
Dry Cargo	Large	21,931.61	5,826.70	3,262.55	31,020.86
Dry Cargo	Medium	4,615.52	1,005.94	182.38	5,803.84
Dry Cargo	Small	3,565.59	353.03	602.70	4,521.32
Tanker	Large	36,417.39	8,256.54	43,112.62	87,786.55
Tanker	Medium	246.93	24.51	58.94	330.38
Tanker	Small	474.67	0.00	223.98	698.65
Tanker Tow	Large	14,633.41	6,689.95	9,292.73	30,616.10
Tanker Tow	Small	99,718.86	17,673.07	27,066.74	144,458.67
Tug/Tow Boat	Small	864.84	191.20	613.08	1,669.13
Totals		184,754.45	40,238.28	85,681.90	310,674.63
Existing VTS Design - Counts					
Passenger	Medium	.03	0.00	.02	.05
Passenger	Small	.27	.05	.15	.47
Dry Cargo	Large	1.51	.42	1.09	3.02
Dry Cargo	Medium	.36	.09	.07	.51
Dry Cargo	Small	1.09	.15	.15	1.39
Tanker	Large	.47	.14	.33	.94
Tanker	Medium	.01	.00	.00	.02
Tanker	Small	.09	0.00	.04	.13
Dry Cargo Tow	Small	.87	.30	.14	1.30
Tanker Tow	Large	.03	.02	.02	.07
Tanker Tow	Small	.94	.20	.28	1.43
Tug/Tow Boat	Small	.36	.11	.11	.58
Totals		6.03	1.48	2.40	9.91
Existing VTS Design - Dollars					
Passenger	Medium	446.89	0.00	233.78	680.67
Passenger	Small	881.86	157.39	611.69	1,650.94
Dry Cargo	Large	14,254.11	4,474.71	2,357.69	21,086.52
Dry Cargo	Medium	3,310.95	906.73	144.27	4,361.95
Dry Cargo	Small	2,113.69	264.04	399.55	2,777.29
Tanker	Large	27,641.99	7,765.88	36,545.35	71,953.21
Tanker	Medium	164.61	19.35	44.26	228.22
Tanker	Small	340.48	0.00	173.94	514.43
Tanker Tow	Large	11,088.77	6,323.80	7,857.33	25,269.90
Tanker Tow	Small	75,680.05	16,323.99	22,901.63	114,905.68
Tug/Tow Boat	Small	644.89	169.29	501.99	1,316.17
Totals		136,568.30	36,405.18	71,771.50	244,744.98

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.04	.02	.06
Dry Cargo	Large	0.00	.17	.07	.24
Dry Cargo	Medium	0.00	.03	.00	.03
Dry Cargo	Small	0.00	.07	.01	.07
Tanker	Large	0.00	.06	.02	.08
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.20	.01	.22
Tanker Barge Tow	Large	0.00	.02	.00	.02
Tanker Barge Tow	Small	0.00	.13	.02	.16
Tug/Tow Boat	Small	0.00	.22	.02	.25
Totals		0.00	.95	.18	1.13
Candidate VTS Design - Dollars					
Passenger	Small	0.00	250.52	89.73	340.24
Dry Cargo	Large	0.00	943.14	403.26	1,346.40
Dry Cargo	Medium	0.00	168.19	22.14	190.33
Dry Cargo	Small	0.00	379.95	32.32	412.27
Tanker	Large	0.00	330.51	104.30	434.82
Tanker	Medium	0.00	3.80	1.32	5.12
Tanker	Small	0.00	0.00	12.92	12.92
Dry Cargo Barge Tow	Small	0.00	1,141.04	74.74	1,215.78
Tanker Barge Tow	Large	0.00	122.07	8.76	130.83
Tanker Barge Tow	Small	0.00	741.15	139.58	880.72
Tug/Tow Boat	Small	0.00	1,265.82	137.87	1,403.69
Totals		0.00	5,346.17	1,026.95	6,373.12
Existing VTS Design - Counts					
Passenger	Small	0.00	.03	.01	.04
Dry Cargo	Large	0.00	.13	.05	.17
Dry Cargo	Medium	0.00	.03	.00	.03
Dry Cargo	Small	0.00	.05	.00	.05
Tanker	Large	0.00	.05	.01	.06
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.16	.01	.17
Tanker Barge Tow	Large	0.00	.02	.00	.02
Tanker Barge Tow	Small	0.00	.11	.02	.13
Tug/Tow Boat	Small	0.00	.18	.02	.20
Totals		0.00	.75	.13	.87
Existing VTS Design - Dollars					
Passenger	Small	0.00	176.84	54.33	231.18
Dry Cargo	Large	0.00	701.34	274.02	975.36
Dry Cargo	Medium	0.00	145.57	17.51	163.08
Dry Cargo	Small	0.00	277.09	21.39	298.48
Tanker	Large	0.00	274.82	79.49	354.31
Tanker	Medium	0.00	2.90	.91	3.81
Tanker	Small	0.00	0.00	9.42	9.42
Dry Cargo Barge Tow	Small	0.00	908.66	52.59	961.26
Tanker Barge Tow	Large	0.00	103.58	6.76	110.34
Tanker Barge Tow	Small	0.00	619.86	106.92	726.78
Tug/Tow Boat	Small	0.00	1,011.34	93.45	1,104.79
Totals		0.00	4,222.01	716.80	4,938.81

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.07	0.00	.07
Dry Cargo	Medium	0.00	.02	0.00	.02
Dry Cargo	Small	.00	.02	0.00	.02
Tanker	Large	0.00	.04	0.00	.04
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.01	.09	0.00	.09
Tanker Barge Tow	Large	0.00	.01	0.00	.01
Tanker Barge Tow	Small	.01	.05	0.00	.06
Tug/Tow Boat	Small	.01	.08	0.00	.09
Totals		.02	.39	0.00	.42
Candidate VTS Design - Dollars					
Passenger	Small	3,052.84	19,595.60	0.00	22,648.45
Dry Cargo	Large	0.00	145,698.19	0.00	145,698.19
Dry Cargo	Medium	0.00	38,603.51	0.00	38,603.51
Dry Cargo	Small	7,655.82	39,338.58	0.00	46,994.40
Tanker	Large	0.00	71,151.68	0.00	71,151.68
Tanker	Medium	0.00	762.49	0.00	762.49
Tanker	Small	970.01	0.00	0.00	970.01
Dry Cargo Barge Tow	Small	13,439.14	174,848.98	0.00	188,288.12
Tanker Barge Tow	Large	0.00	29,658.62	0.00	29,658.62
Tanker Barge Tow	Small	13,166.16	99,305.97	0.00	112,472.13
Tug/Tow Boat	Small	11,127.55	162,190.86	0.00	173,318.41
Totals		49,411.52	781,154.48	0.00	830,566.00
Existing VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.07	0.00	.07
Dry Cargo	Medium	0.00	.02	0.00	.02
Dry Cargo	Small	.00	.02	0.00	.02
Tanker	Large	0.00	.03	0.00	.03
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.07	0.00	.08
Tanker Barge Tow	Large	0.00	.01	0.00	.01
Tanker Barge Tow	Small	.00	.04	0.00	.05
Tug/Tow Boat	Small	.00	.07	0.00	.08
Totals		.02	.34	0.00	.36
Existing VTS Design - Dollars					
Passenger	Small	948.23	11,016.45	0.00	11,964.68
Dry Cargo	Large	0.00	136,648.19	0.00	136,648.19
Dry Cargo	Medium	0.00	36,895.68	0.00	36,895.68
Dry Cargo	Small	4,794.46	31,530.67	0.00	36,325.13
Tanker	Large	0.00	68,506.58	0.00	68,506.58
Tanker	Medium	0.00	729.14	0.00	729.14
Tanker	Small	666.94	0.00	0.00	666.94
Dry Cargo Barge Tow	Small	8,839.42	143,630.50	0.00	152,469.92
Tanker Barge Tow	Large	0.00	27,120.45	0.00	27,120.45
Tanker Barge Tow	Small	9,260.86	84,454.66	0.00	93,715.52
Tug/Tow Boat	Small	8,686.53	148,413.17	0.00	157,099.70
Totals		33,196.44	688,945.49	0.00	722,141.93

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix K Zone 11 New York, NY
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	.00	.00	.01	.02	.02
ALCOHOLS	.00	.01	.02	.07	.10
KEROSENE	.00	.00	.02	.00	.02
JET FUEL	.00	.01	.03	.00	.04
CRUDE PETROLEUM	.01	.04	.02	.00	.07
DISTILLATE FUEL OIL	.03	.10	.38	2.24	2.76
RESIDUAL FUEL OIL	.04	.12	1.37	2.27	3.80
GASOLINE, INCL NATURAL	.05	.17	.55	.03	.81
	.13	.46	2.39	4.64	7.62
Existing Vts Design - Counts					
BENZENE AND TOLUENE	.00	.00	.00	.01	.02
ALCOHOLS	.00	.01	.01	.05	.07
KEROSENE	.00	.00	.01	.00	.02
JET FUEL	.00	.01	.02	.00	.03
CRUDE PETROLEUM	.01	.03	.01	.00	.05
DISTILLATE FUEL OIL	.02	.08	.29	1.39	1.78
RESIDUAL FUEL OIL	.03	.09	.97	1.56	2.65
GASOLINE, INCL NATURAL	.04	.13	.41	.02	.60
	.09	.34	1.72	3.04	5.20

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix K　　Zone 11 New York, NY　　7/31/91
TABLE 18A　　Annual Benefit & Cost Streams
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,234	0	0
1996	0	1,220	2,060
1997	0	1,109	2,100
1998	0	1,009	3,297
1999	0	917	3,496
2000	0	834	3,250
2001	0	758	3,022
2002	0	689	2,778
2003	0	626	2,416
2004	0	569	2,385
2005	0	518	1,784
2006	0	471	2,081
2007	0	428	1,887
2008	0	389	1,757
2009	0	354	1,681
2010	0	321	1,488
	16,234	10,211	35,480

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	16,234	0	0
1996	0	1,551	2,617
1997	0	1,551	2,935
1998	0	1,551	5,068
1999	0	1,551	5,911
2000	0	1,551	6,045
2001	0	1,551	6,184
2002	0	1,551	6,253
2003	0	1,551	5,981
2004	0	1,551	6,494
2005	0	1,551	5,344
2006	0	1,551	6,859
2007	0	1,551	6,839
2008	0	1,551	7,006
2009	0	1,551	7,372
2010	0	1,551	7,180
	16,234	23,258	88,089

Appendix K Zone 11 New York, NY
TABLE 18B Annual Benefit & Cost Streams 7/31/91
Existing VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	2,558	1,170
1997	0	2,325	1,360
1998	0	2,114	2,402
1999	0	1,922	2,536
2000	0	1,747	2,353
2001	0	1,588	2,165
2002	0	1,444	1,943
2003	0	1,313	1,796
2004	0	1,193	1,750
2005	0	1,085	1,220
2006	0	986	1,466
2007	0	897	1,361
2008	0	815	1,283
2009	0	741	1,208
2010	0	674	1,108
	0	21,402	25,122

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	3,250	1,486
1997	0	3,250	1,901
1998	0	3,250	3,693
1999	0	3,250	4,288
2000	0	3,250	4,376
2001	0	3,250	4,431
2002	0	3,250	4,374
2003	0	3,250	4,448
2004	0	3,250	4,765
2005	0	3,250	3,656
2006	0	3,250	4,831
2007	0	3,250	4,932
2008	0	3,250	5,115
2009	0	3,250	5,301
2010	0	3,250	5,348
	0	48,750	62,945

APPENDIX K

ZONE 11 - NEW YORK CITY, NY

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1101	101	1	American Shad	.0043	.0043	.0043	.0043
1101	101	2	Alewife	.2100	.2100	.2100	.2100
1101	102	4	Atl.Herring	.1959	0.0000	0.0000	.1959
1101	102	5	Butterfish	4.3479	4.3479	4.3479	4.3479
1101	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1101	102	32	King Mackerel	.0190	.0190	.0190	0.0000
1101	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1101	102	127	Silversides	4.0000	5.0000	7.8000	7.8000
1101	103	8	Bluefish	1.6060	1.6060	1.6060	0.0000
1101	103	9	Striped Bass	.0047	.4700	.0094	.0094
1101	103	10	Monkfish	.0770	.0770	.0770	.0770
1101	103	11	Weakfish	0.0000	.4701	.4701	0.0000
1101	104	13	Swordfish	.0330	.0330	.0330	.0330
1101	104	14	Shark	.0041	.0041	.0041	.0041
1101	104	15	Dogfish	.9900	.9900	.9900	.9900
1101	105	16	Yellowtail Flounder	.1959	.1959	0.0000	0.0000
1101	105	17	Summer Flounder	0.0000	.3917	.3917	0.0000
1101	105	20	Winter Flounder	1.2246	.1567	.1567	1.2246
1101	105	251	Windowpane Flounder	.7838	.9793	.9793	.9793
1101	106	23	Redfish	.1469	0.0000	0.0000	0.0000
1101	106	24	Silver Hake	.6900	.6900	.6900	.6900
1101	106	25	Red Hake	.6600	.6600	.6600	.6600
1101	106	27	Scup	2.9770	2.9770	2.9770	0.0000
1101	106	28	Tilefish	.0330	.0330	.0330	.0330
1101	106	29	Black Sea Bass	.1175	.1175	.1175	0.0000
1101	106	35	Croaker	.0470	.0470	.0470	.0470
1101	106	109	Longhorn Sculpin	.1959	0.0000	0.0000	.1959
1101	106	116	Little Skate	2.9881	0.0000	0.0000	2.9881
1101	106	116	Winter Skate	1.3716	0.0000	0.0000	1.3716
1101	106	199	Other	.8327	10.3658	19.8989	10.3658
1101	106	254	Ocean Pout	.7348	.7348	.7348	.7348
1101	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1101	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1101	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1101	107	213	Hard Clam	585.0000	585.0000	585.0000	585.0000
1101	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1101	108	204	American Lobster	2.7921	1.4156	.0392	1.4156
1101	108	206	Red Crab	.2300	.2300	.2300	.2300
1101	109	207	Long Fin Squid	.6200	2.6440	2.6440	.6200
1102	101	1	American Shad	.0043	.0043	.0043	.0043
1102	101	2	Alewife	.2100	.2100	.2100	.2100
1102	102	4	Atl.Herring	.1959	0.0000	0.0000	.1959
1102	102	5	Butterfish	4.3479	4.3479	4.3479	4.3479
1102	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1102	102	32	King Mackerel	.0190	.0190	.0190	0.0000
1102	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1102	102	127	Silversides	4.0000	5.0000	7.8000	7.8000
1102	103	8	Bluefish	1.6060	1.6060	1.6060	0.0000
1102	103	9	Striped Bass	.0047	.4700	.0094	.0094
1102	103	10	Monkfish	.0770	.0770	.0770	.0770
1102	103	11	Weakfish	0.0000	.4701	.4701	0.0000
1102	104	13	Swordfish	.0330	.0330	.0330	.0330
1102	104	14	Shark	.0041	.0041	.0041	.0041

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1102	104	15	Dogfish	.9900	.9900	.9900	.9900
1102	105	16	Yellowtail Flounder	.1959	.1959	0.0000	0.0000
1102	105	17	Summer Flounder	0.0000	.3917	.3917	0.0000
1102	105	20	Winter Flounder	1.2246	.1567	.1567	1.2246
1102	105	251	Windowpane Flounder	.7838	.9793	.9793	.9793
1102	106	23	Redfish	.1469	0.0000	0.0000	0.0000
1102	106	24	Silver Hake	.6900	.6900	.6900	.6900
1102	106	25	Red Hake	.6600	.6600	.6600	.6600
1102	106	27	Scup	2.9770	2.9770	2.9770	0.0000
1102	106	28	Tilefish	.0330	.0330	.0330	.0330
1102	106	29	Black Sea Bass	.1175	.1175	.1175	0.0000
1102	106	35	Croaker	.0470	.0470	.0470	.0470
1102	106	109	Longhorn Sculpin	.1959	0.0000	0.0000	.1959
1102	106	116	Little Skate	2.9881	0.0000	0.0000	2.9881
1102	106	116	Winter Skate	1.3716	0.0000	0.0000	1.3716
1102	106	199	Other	.8327	10.3658	19.8989	10.3658
1102	106	254	Ocean Pout	.7348	.7348	.7348	.7348
1102	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1102	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1102	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1102	107	213	Hard Clam	990.0000	990.0000	990.0000	990.0000
1102	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1102	108	204	American Lobster	2.7921	1.4156	.0392	1.4156
1102	108	206	Red Crab	.2300	.2300	.2300	.2300
1102	109	207	Long Fin Squid	.6200	2.6440	2.6440	.6200
1103	101	1	American Shad	.0043	.0043	.0043	.0043
1103	101	2	Alewife	.2100	.2100	.2100	.2100
1103	102	4	Atl.Herring	.1959	0.0000	0.0000	.1959
1103	102	5	Butterfish	4.3479	4.3479	4.3479	4.3479
1103	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1103	102	32	King Mackerel	.0190	.0190	.0190	0.0000
1103	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1103	102	127	Silversides	4.0000	5.0000	7.8000	.1000
1103	103	8	Bluefish	1.6060	1.6060	1.6060	0.0000
1103	103	9	Striped Bass	.0047	.4700	.0094	.0094
1103	103	10	Monkfish	.0770	.0770	.0770	.0770
1103	103	11	Weakfish	0.0000	.4701	.4701	0.0000
1103	104	13	Swordfish	.0330	.0330	.0330	.0330
1103	104	14	Shark	.0041	.0041	.0041	.0041
1103	104	15	Dogfish	.9900	.9900	.9900	.9900
1103	105	16	Yellowtail Flounder	.1959	.1959	0.0000	0.0000
1103	105	17	Summer Flounder	0.0000	.3917	.3917	0.0000
1103	105	20	Winter Flounder	1.2246	.1567	.1567	1.2246
1103	105	251	Windowpane Flounder	.7838	.9793	.9793	.9793
1103	106	23	Redfish	.1469	0.0000	0.0000	0.0000
1103	106	24	Silver Hake	.6900	.6900	.6900	.6900
1103	106	25	Red Hake	.6600	.6600	.6600	.6600
1103	106	27	Scup	2.9770	2.9770	2.9770	0.0000
1103	106	28	Tilefish	.0330	.0330	.0330	.0330
1103	106	29	Black Sea Bass	.1175	.1175	.1175	0.0000
1103	106	35	Croaker	.0470	.0470	.0470	.0470
1103	106	109	Longhorn Sculpin	.1959	0.0000	0.0000	.1959
1103	106	116	Little Skate	2.9881	0.0000	0.0000	2.9881

APPENDIX K

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor Port & Subzone	Species Category	(Port 11) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1103	106	116	Winter Skate	1.3716	0.0000	0.0000	1.3716
1103	106	199	Other	.8327	10.3658	19.8989	10.3658
1103	106	254	Ocean Pout	.7348	.7348	.7348	.7348
1103	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1103	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1103	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1103	107	213	Hard Clam	450.0000	450.0000	450.0000	450.0000
1103	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1103	108	204	American Lobster	2.7921	1.4156	.0392	1.4156
1103	108	206	Red Crab	.2300	.2300	.2300	.2300
1103	109	207	Long Fin Squid	.6200	2.6440	2.6440	.6200
1104	101	1	American Shad	.1200	.0580	0.0000	.0580
1104	101	2	Alewife	.4100	.4100	.4100	.4100
1104	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1104	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1104	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1104	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1104	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1104	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1104	102	34	Harvestfish	.0010	.0010	.0010	.0010
1104	102	127	Silversides	4.0000	5.0000	7.8000	.1000
1104	103	8	Bluefish	.2700	.3200	.3200	0.0000
1104	103	9	Striped Bass	.2600	.4700	.4200	.4200
1104	103	11	Weakfish	.3100	.3100	.3100	.0070
1104	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1104	105	18	American Plaice	.0170	.0090	.0090	.0100
1104	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1104	106	24	Silver Hake	.0010	.0010	.0010	.0010
1104	106	25	Red Hake	.0040	.0200	.0030	.0030
1104	106	26	White Hake	.0090	.0140	.0050	0.0000
1104	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1104	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1104	106	36	Drum	.0020	.0020	.0020	0.0000
1104	106	37	Spot	.0960	.0490	0.0000	.0490
1104	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1104	106	39	Carp	.0250	.0250	.0250	.0250
1104	106	40	Eel	.1400	.1400	.1400	.1400
1104	106	199	Other	.7800	.7800	.7800	.7800
1104	107	211	Soft Clam	.1700	.1700	.1700	.1700
1104	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000
1104	107	213	Hard Clam	.0800	.0800	.0800	.0800
1104	107	214	Conch	.0660	.0660	.0660	.0660
1104	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1104	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1104	108	214	American Lobster	.1100	.2200	.1100	0.0000
1104	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000
1105	101	1	American Shad	.1200	.0580	0.0000	.0580
1105	101	2	Alewife	.4100	.4100	.4100	.4100
1105	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1105	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1105	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1105	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1105	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1105	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1105	102	34	Harvestfish	.0010	.0010	.0010	.0010
1105	103	8	Bluefish	.2700	.3200	.3200	0.0000
1105	103	9	Striped Bass	.2600	.4700	.4200	.4200
1105	103	11	Weakfish	.3100	.3100	.3100	.0070
1105	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1105	105	18	American Plaice	.0170	.0090	.0090	.0100
1105	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1105	106	24	Silver Hake	.0010	.0010	.0010	.0010
1105	106	25	Red Hake	.0040	.0200	.0030	.0030
1105	106	26	White Hake	.0090	.0140	.0050	0.0000
1105	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1105	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1105	106	36	Drum	.0020	.0020	.0020	0.0000
1105	106	37	Spot	.0960	.0490	0.0000	.0490
1105	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1105	106	39	Carp	.0250	.0250	.0250	.0250
1105	106	40	Eel	.1400	.1400	.1400	.1400
1105	106	199	Other	.7800	.7800	.7800	.7800
1105	107	211	Soft Clam	.1700	.1700	.1700	.1700
1105	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000
1105	107	213	Hard Clam	.0800	.0800	.0800	.0800
1105	107	214	Conch	.0660	.0660	.0660	.0660
1105	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1105	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1105	108	214	American Lobster	.1100	.2200	.1100	0.0000
1105	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000
1106	101	1	American Shad	.1200	.0580	0.0000	.0580
1106	101	2	Alewife	.4100	.4100	.4100	.4100
1106	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1106	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1106	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1106	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1106	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1106	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1106	102	34	Harvestfish	.0010	.0010	.0010	.0010
1106	103	8	Bluefish	.2700	.3200	.3200	0.0000
1106	103	9	Striped Bass	.2600	.4700	.4200	.4200
1106	103	11	Weakfish	.3100	.3100	.3100	.0070
1106	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1106	105	18	American Plaice	.0170	.0090	.0090	.0100
1106	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1106	106	24	Silver Hake	.0010	.0010	.0010	.0010
1106	106	25	Red Hake	.0040	.0200	.0030	.0030
1106	106	26	White Hake	.0090	.0140	.0050	0.0000
1106	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1106	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1106	106	36	Drum	.0020	.0020	.0020	0.0000
1106	106	37	Spot	.0960	.0490	0.0000	.0490
1106	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1106	106	39	Carp	.0250	.0250	.0250	.0250
1106	106	40	Eel	.1400	.1400	.1400	.1400
1106	106	199	Other	.7800	.7800	.7800	.7800
1106	107	211	Soft Clam	.1700	.1700	.1700	.1700
1106	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor Port & Subzone	Species Category	(Port 11) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1106	107	213	Hard Clam	.0800	.0800	.0800	.0800
1106	107	214	Conch	.0660	.0660	.0660	.0660
1106	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1106	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1106	108	214	American Lobster	.1100	.2200	.1100	0.0000
1106	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000
1107	101	1	American Shad	.7250	7.6250	6.1500	.7260
1107	101	2	Alewife	.3000	6.4000	4.2500	0.0000
1107	101	2	Blueback Herring	.4200	.5200	18.5400	0.0000
1107	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1107	102	3	Menhaden	21.1000	22.4000	11.2000	0.0000
1107	102	4	Herring	.0010	.0010	.0010	.0010
1107	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1107	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1107	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0211
1107	102	34	Harvestfish	.0010	.0010	.0010	.0010
1107	102	43	Bay Anchovy	1.8900	2.7100	.1300	.1300
1107	102	126	Pumpkinseed	.0040	.0003	.0010	.0010
1107	102	127	Atlantic Silverside	.3000	.3400	.1350	.1350
1107	102	256	Four-spine Stickleback	.0020	.0010	.0030	.0010
1107	102	260	Golden Shiner	.0400	0.0000	0.0000	.0400
1107	102	260	Spot-tail Shiner	.3300	.0500	.0550	.0500
1107	103	8	Bluefish	1.2000	3.0000	.1000	0.0000
1107	103	9	Striped Bass	3.6000	44.8000	23.2000	3.6000
1107	103	11	Monkfish	.3100	.3100	.3100	.0070
1107	106	24	Silver Hake	.0010	.0010	.0010	.0010
1107	106	25	Red Hake	.0040	.0020	.0030	.0030
1107	106	26	White Hake	.0090	.0140	.0050	0.0000
1107	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1107	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1107	106	36	Drum	.0020	.0020	.0020	0.0000
1107	106	37	Spot	.0960	.0490	0.0000	.0490
1107	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1107	106	39	American Eel	2.1000	1.3000	.3000	.3000
1107	106	40	Eel	.1400	.1400	.1400	.1400
1107	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
1107	106	103	Rainbow Smelt	.0600	0.0000	0.0000	.0600
1107	106	123	White Perch	15.5500	30.7500	16.3000	15.0000
1107	106	126	Sunfish	.0100	0.0000	0.0000	0.0000
1107	106	127	Tessellated Darter	.1600	.1200	0.0000	.1200
1107	106	142	Banded Killifish	.0050	.0210	.0030	.0040
1107	106	199	Carp	.0800	.0400	0.0000	.0400
1107	106	199	Mummichog	5.3000	.4650	.1150	.1150
1107	106	199	Other	.1200	.2400	.2000	.1500
1107	106	199	White Sucker	.0800	0.0000	0.0000	0.0000
1107	106	243	Hogchoker	0.0000	.2500	0.0000	0.0000
1107	106	244	Northern Pipefish	.0400	.0100	.0100	.0100
1107	106	250	Atlantic Tomcod	8.0000	.1500	.2000	.2000
1107	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1107	107	214	Conch	.0660	.0660	.0660	.0660
1107	108	204	American Lobster	.2200	.4400	.2200	0.0000
1107	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1107	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1107	109	207	Squid	.0280	.1500	.1300	0.0000

APPENDIX K

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1101	202	1199	Larvae	.1900	.8100	.8100	.2200
1101	203	1199	Larvae	.0110	.1900	.0054	0.0000
1101	205	1199	Larvae	1.1000	.6600	.3600	.0040
1101	206	1199	Larvae	.0270	.4700	1.0400	.0200
1101	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1101	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1102	202	1199	Larvae	.1900	.8100	.8100	.2200
1102	203	1199	Larvae	.0110	.1900	.0054	0.0000
1102	205	1199	Larvae	1.1000	.6600	.3600	.0040
1102	206	1199	Larvae	.0270	.4700	1.0400	.0200
1102	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1102	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1103	202	1199	Larvae	.1900	.8100	.8100	.2200
1103	203	1199	Larvae	.0110	.1900	.0054	0.0000
1103	205	1199	Larvae	1.1000	.6600	.3600	.0040
1103	206	1199	Larvae	.0270	.4700	1.0400	.0200
1103	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1103	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1104	202	1199	Larvae	12.4000	52.7000	53.4000	14.3000
1104	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1104	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1104	206	1199	Larvae	.2100	3.6000	8.0000	.1500
1104	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1104	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1105	202	1199	Larvae	12.4000	52.7000	53.4000	14.3000
1105	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1105	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1105	206	1199	Larvae	.2100	3.6000	8.0000	.1500
1105	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1105	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1106	201	1001	American Shad	1.4000	1.4000	0.0000	0.0000
1106	201	1114	Blue Back Herring/Alewife	210.0000	210.0000	0.0000	0.0000
1106	202	1003	Atlantic Menhaden	.9100	.9100	0.0000	0.0000
1106	202	1004	Atlantic Herring	.2800	.2800	0.0000	0.0000
1106	202	1005	Butterfish	.1400	.1400	0.0000	0.0000
1106	202	1043	Anchovy	1659.0000	1659.0000	1659.0000	0.0000
1106	202	1127	Atlantic Silverside	.0700	.0700	0.0000	0.0000
1106	202	1127	Tessellated Darter	1.0500	1.0500	0.0000	0.0000
1106	202	1199	Larvae	0.0000	0.0000	0.0000	14.3000
1106	203	1008	Bluefish	.0700	.0700	0.0000	0.0000
1106	203	1009	Striped Bass	9.8000	9.8000	0.0000	0.0000
1106	203	1010	Goosefish	.0700	.0700	0.0000	0.0000
1106	203	1011	Weakfish	.2100	.2100	0.0000	0.0000
1106	203	1199	Larvae	0.0000	0.0000	.0310	0.0000
1106	205	1016	Yellow Tail Flounder	.0700	.0700	0.0000	0.0000
1106	205	1017	Summer Flounder	.1400	.1400	0.0000	0.0000
1106	205	1020	Winter Flounder	13.3000	13.3000	0.0000	0.0000
1106	205	1199	Larvae	0.0000	0.0000	3.6000	.0400
1106	205	1251	Windowpane	.2100	.2100	0.0000	0.0000
1106	206	1021	Atlantic Cod	.0700	.0700	0.0000	0.0000
1106	206	1035	Atlantic Croaker	0.0000	.6600	.6600	.6600
1106	206	1036	Yellow Perch	.1400	.1400	0.0000	0.0000
1106	206	1039	Carp	.3500	.3500	0.0000	0.0000
1106	206	1040	Amer. Eel	.4200	.4200	0.0000	0.0000

APPENDIX K

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1106	206	1048	Brown Bullhead	.0700	.0700	0.0000	0.0000
1106	206	1103	Rainbow Smelt	7.7000	7.7000	0.0000	0.0000
1106	206	1109	Sculpin	.7700	.7700	0.0000	0.0000
1106	206	1123	White Perch	51.8000	51.8000	0.0000	0.0000
1106	206	1199	Blue Gill	.1400	.1400	0.0000	0.0000
1106	206	1199	Larvae	0.0000	0.0000	8.0000	.1500
1106	206	1199	Lined Seahorse	.0700	.0700	0.0000	0.0000
1106	206	1243	Hogchoaker	6.1600	6.1600	0.0000	0.0000
1106	206	1244	Northern Pipefish	1.8200	1.8200	0.0000	0.0000
1106	206	1252	Four Beard Rockling	.1400	.1400	0.0000	0.0000
1106	206	1255	Conner	.0700	.0700	0.0000	0.0000
1106	206	1259	Atlantic Tam Cod	84.0000	84.0000	0.0000	0.0000
1106	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1106	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1107	201	1001	American Shad	1.4000	1.4000	0.0000	0.0000
1107	201	1114	Blue Back Herring/Alewife	210.0000	210.0000	0.0000	0.0000
1107	202	1003	Atlantic Menhaden	.9100	.9100	0.0000	0.0000
1107	202	1004	Atlantic Herring	.2800	.2800	0.0000	0.0000
1107	202	1005	Butterfish	.1400	.1400	0.0000	0.0000
1107	202	1043	Anchovy	1659.0000	1659.0000	1659.0000	0.0000
1107	202	1127	Atlantic Silverside	.0700	.0700	0.0000	0.0000
1107	202	1127	Tessellated Darter	1.0500	1.0500	0.0000	0.0000
1107	203	1008	Bluefish	.0700	.0700	0.0000	0.0000
1107	203	1009	Striped Bass	9.8000	9.8000	0.0000	0.0000
1107	203	1010	Goosefish	.0700	.0700	0.0000	0.0000
1107	203	1011	Weakfish	.2100	.2100	0.0000	0.0000
1107	203	1199	Larvae	0.0000	0.0000	.0310	0.0000
1107	205	1016	Yellow Tail Flounder	.0700	.0700	0.0000	0.0000
1107	205	1017	Summer Flounder	.1400	.1400	0.0000	0.0000
1107	205	1020	Winter Flounder	13.3000	13.3000	0.0000	0.0000
1107	205	1251	Windowpane	.2100	.2100	0.0000	0.0000
1107	206	1021	Atlantic Cod	.0700	.0700	0.0000	0.0000
1107	206	1035	Atlantic Croaker	0.0000	.6600	.6600	.6600
1107	206	1036	Yellow Perch	.1400	.1400	0.0000	0.0000
1107	206	1039	Carp	.3500	.3500	0.0000	0.0000
1107	206	1040	Amer. Eel	.4200	.4200	0.0000	0.0000
1107	206	1048	Brown Bullhead	.0700	.0700	0.0000	0.0000
1107	206	1103	Rainbow Smelt	7.7000	7.7000	0.0000	0.0000
1107	206	1109	Sculpin	.7700	.7700	0.0000	0.0000
1107	206	1123	White Perch	51.8000	51.8000	0.0000	0.0000
1107	206	1199	Blue Gill	.1400	.1400	0.0000	0.0000
1107	206	1199	Lined Seahorse	.0700	.0700	0.0000	0.0000
1107	206	1243	Hogchoaker	6.1600	6.1600	0.0000	0.0000
1107	206	1244	Northern Pipefish	1.8200	1.8200	0.0000	0.0000
1107	206	1252	Four Beard Rockling	.1400	.1400	0.0000	0.0000
1107	206	1255	Conner	.0700	.0700	0.0000	0.0000
1107	206	1259	Atlantic Tam Cod	84.0000	84.0000	0.0000	0.0000
1107	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1107	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX K

ZONE 11 - NEW YORK CITY, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor Port & Subzone	Species Category	(Port 11) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1101	111	515	Diving Ducks	46.0740	4.6944	17.8889	59.3472
1101	111	516	Loons	.0800	0.0000	.0300	.0200
1101	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1101	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1101	113	531	Gulls	8.8900	.8300	4.2300	8.7300
1101	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1101	113	533	Terns	.1900	.0200	.0100	0.0000
1101	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1101	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000
1101	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1101	113	534	Manx Shearwater	0.0000	.0100	.0100	0.0000
1101	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1101	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1101	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1101	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1101	113	535	Skua	.0100	.0100	.0100	.0100
1101	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1101	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1101	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1101	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1101	113	538	Murre	.0100	0.0000	0.0000	.0400
1101	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1101	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1101	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1101	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000
1101	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1101	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1101	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1101	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1101	114	584	Owls	0.0000	0.0000	0.0000	.0010
1102	111	515	Diving Ducks	46.0740	4.6944	17.8889	59.3472
1102	111	516	Loons	.0800	0.0000	.0300	.0200
1102	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1102	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1102	113	531	Gulls	8.8900	.8300	4.2300	8.7300
1102	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1102	113	533	Terns	.1900	.0200	.0100	0.0000
1102	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1102	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000
1102	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1102	113	534	Manx Shearwater	0.0000	.0100	.0100	0.0000
1102	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1102	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1102	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1102	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1102	113	535	Skua	.0100	.0100	.0100	.0100
1102	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1102	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1102	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1102	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1102	113	538	Murre	.0100	0.0000	0.0000	.0400
1102	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1102	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1102	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1102	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

New York Harbor		(Port 11)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1102	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1102	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1102	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1102	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1102	114	584	Owls	0.0000	0.0000	0.0000	.0010
1103	111	515	Diving Ducks	46.0740	4.6944	17.8889	59.3472
1103	111	516	Loons	.0800	0.0000	.0300	.0200
1103	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1103	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1103	113	531	Gulls	8.8900	.8300	4.2300	8.7300
1103	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1103	113	533	Terns	.1900	.0200	.0100	0.0000
1103	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1103	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000
1103	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1103	113	534	Manx Shearwater	0.0000	.0100	.0100	0.0000
1103	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1103	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1103	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1103	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1103	113	535	Skua	.0100	.0100	.0100	.0100
1103	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1103	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1103	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1103	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1103	113	538	Murre	.0100	0.0000	0.0000	.0400
1103	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1103	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1103	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1103	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000
1103	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1103	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1103	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1103	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1103	114	584	Owls	0.0000	0.0000	0.0000	.0010
1104	111	511	Dabbling Ducks	276.1296	847.1110	1243.8778	240.7222
1104	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1104	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1104	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1104	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1104	113	531	Black Back Gulls	3.5185	3.4259	4.9074	12.5000
1104	113	531	Herring Gulls	39.3518	24.0741	41.6667	94.4400
1104	113	531	Laughing Gulls	0.0000	.2778	1.2500	.2778
1104	113	531	Ring Billed Gulls	2.5463	.9259	2.2685	2.7778
1105	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1105	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1105	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1105	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1105	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1105	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1106	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1106	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1106	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1106	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1106	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1106	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000

★U.S. GOVERNMENT PRINTING OFFICE: 1991-501-524/40026

than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

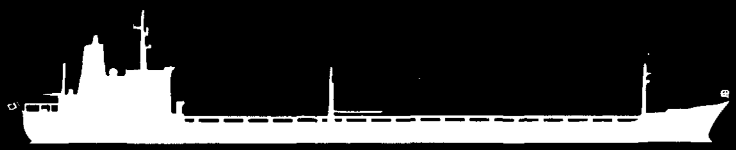
KT-32

Port Needs Study (Vessel Traffic Services Benefits)

Study Overview

Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142-1093

August 1991



U. S. Department of Transportation

United States Coast Guard

Office of Navigation Safety and Waterway Services
Washington, DC 20593

The Port Needs Study - Vessel Traffice Services Benefits is documented in three separately bound volumes. Volume I is the main document covering all aspects of the inputs, analyses and results. Volume II contains the appendix tables of input data and output statistics and the details of the Candidate VTS Design for each study zone. Volume III is a compendium of technical papers covering data, analytical methods and models supplementing the material in Volume I. All three volumes are available from the National Technical Information Service, Springfield, VA 22161.

Table of Contents

Purpose

This study documents the benefits and costs of potential U.S. Coast Guard Vessel Traffic Services (VTS) in selected U.S. deep draft ports on the Atlantic, Gulf and Pacific coasts. The U.S. Department of Transportation, Research and Special Programs Administration (RSPA), Volpe National Transportation Systems Center (VNTSC) conducted the study for the U.S. Coast Guard, Office of Navigation Safety and Waterway Services, Special Projects Staff. The study started in February 1990 as a Coast Guard initiative, prior to the passage of the "The Oil Pollution Act of 1990" (Public Law 101-380). This initiative satisfies the requirements of the Act.

Background

The concept of VTS has gained international acceptance by governments and maritime industries, as a means of advancing safety in rapidly expanding ports and waterways. Vessel Traffic Services work through position and situation advisory communications with vessels navigating the waterways. VTS communications are advisory in nature, providing timely and accurate information to the mariner, thus enhancing the potential for avoiding vessel casualties. VTS do not exercise direct control by ordering specific course directions or speeds to maneuver around hazards. "While the Vessel Control Center (VTC) will have the authority to direct the movement of a vessel in a dangerous situation, a master remains responsible for the safe and prudent manuevering of the vessel at all times."[1]

Several spills following within three months of the Prince William Sound incident of March 1989 (i.e., one in the coastal waters of Rhode Island, one in the Delaware River, and one in the Houston Ship Channel) drew intense congressional interest and resulted in the passage of "The Oil Pollution Act of 1990" (Public Law 101-380) on August 18, 1990. The Act requires the "Secretary to conduct a study...to determine and prioritize the U.S. ports and channels that are in need of new, expanded, or improved vessel traffic service systems... ." The Act further requires that the results of the study be submitted to Congress not later than one year after enactment of the Act.

Several studies have been performed prior to this study:

1. The USCG Study Report - Vessel Traffic Systems Analysis of Port Needs (August 1973)
2. The BMC Hong Kong VTS Study, Operational Solutions and Alternatives, Volume II, Site Configuration and Equipment Analysis (June 1984)
3. The European Economic Community Study-COST 301, (June 1987)
4. The Canadian Ministry of Supply and Services, Bureau of Management Consulting (BMC) Study- Vessel Traffic Services (October 1984) and Update Study (February 1988)

This study builds upon the experience of the earlier efforts and provides the most comprehensive quantitative analysis to date of VTS benefits and costs.

Approach

This study analyzes historical vessel casualties and their consequences and projects future vessel casualties and consequences for 23 study zones. The study uses a benefit-cost approach and focuses on navigational risk measured in terms of probabilities of vessel collisions, rammings or groundings, and the human and environmental consequences and economic losses that attend vessel casualties. VTS benefits are defined as the avoided vessel casualties and the associated

1 Federal Register, Vol. 55, No. 166, August 27, 1990, Rules and Regulations pg. 34909

Approach *(cont'd.)*

consequences. The avoided consequences are measured in physical units and are assigned monetary values. VTS costs are defined as the initial federal investment for a state of the art VTS system in each study zone and its annual operating and maintenance costs. A candidate VTS Design in each study zone is projected to reduce the risk of vessel casualties and their consequences during the period 1996 - 2010.

The study approach consists of the following seven steps:

1. Defining study zones and subzones.
2. Analyzing historical vessel casualties.
3. Forecasting avoidable future vessel casualties in each study zone.
4. Estimating the avoidable consequences in each study zone, the associated physical losses, and the dollar values of these avoidable losses.
5. Estimating the cost of a state-of-the-art Candidate VTS Design for each study zone.
6. Comparing the benefits and costs among the 23 study zones.
7. Analysis of sensitivity of relative net benefits among the study zones to a range of uncertainty in key input variables.

The VTS Benefits =

Forecasted Vessel Transits x
Probability of a Vessel Casualty x
VTS Effectiveness x
Probability of a Consequence x
Probability of Consequence Severity x
Unit Dollar Value of the Consequence

The life cycle annual stream of dollar values of benefits are discounted (at 10% per year) and are compared to the discounted annual stream of VTS costs to provide the Net Benefits for each study zone.

Study Zones and Subzones

After consulting with each of the Regional Offices, Captains of The Port, and headquarters personnel, the Coast Guard Special Projects Staff selected the 23 study zones to be analyzed as shown on the map in Figure 1.

Each study zone incorporates at least one major port, at least one major navigational challenge, and at least one environmentally sensitive area. In total, the boundaries of the 23 study zones encompass 82 deep draft ports, which load and unload over 80% of the U.S. total international and domestic cargo vessel tonnage, and enclose approximately 64% of the 1979-1989 vessel casualties in U.S. waters that were potentially VTS addressable.

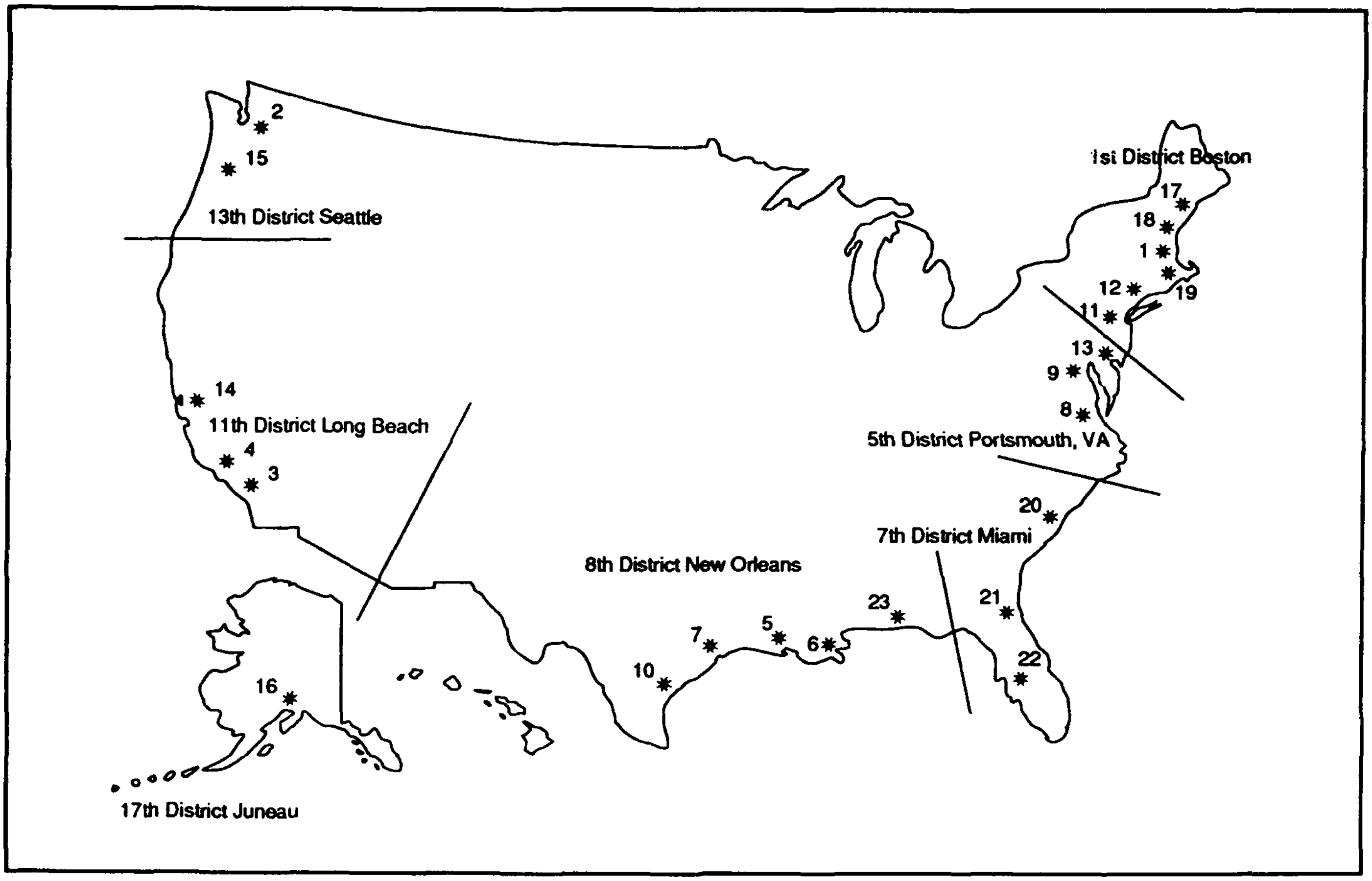
In order to perform a zone-by-zone evaluation, the following generic subzone (waterbody) types are established. Each subzone type characterizes the common navigational attributes of the waterways within each study zone.

1. Open Approach
2. Convergence
3. Open Harbor or Bay
4. Enclosed Harbor
5. Constricted Waterway
6. River

Using these waterbody types, the 23 study zones are divided into a total of 99 subzones for all the analyses.

Vessel Casualties

Historical casualties are analyzed to develop an understanding of the causes, circumstances and consequences of vessel casualties and to aid in modeling navigational risk and the estimation of casualties which would be avoided by operation of a VTS system. From the Coast Guard central file, 36,000 vessel casualty records are within the 23 study zone boundaries for the period 1979 to 1989;



Study Zone Code	Study Zone Name	Study Zone Code	Study Zone Name
1	Boston, MA	12	Long Island Sound, NY
2	Puget Sound, WA	13	Philadelphia/Delaware Bay, PA
3	Los Angeles/Long Beach, CA	14	San Francisco, CA
4	Santa Barbara, CA	15	Portland, OR
5	Port Arthur, TX	16	Anchorage/Cook Inlet, AK
6	New Orleans, LA	17	Portland, ME
7	Houston/Galveston, TX	18	Portsmouth, NH
8	Chesapeake South/Hampton Roads, VA	19	Providence, RI
9	Chesapeake North/Baltimore, MD	20	Wilmington, NC
10	Corpus Christi, TX	21	Jacksonville, FL
11	New York City, NY	22	Tampa, FL
		23	Mobile, AL

Figure 1. VTS Study Zones

Vessel Casualties *(cont'd.)*

a total of 2,210 are selected as "VTS addressable." These are casualties that are considered to be "addressable" by the Coast Guard Candidate VTS system.

- Addressable Incidents
  - Open water collisions between two vessels caused by surprise, poor visibility, severe weather, or simple miscalculation on the bridge.
  - Certain overtaking situations.
  - Collisions during situations when vessels are not anchored in confined waters where the vessel enters a congested channel or waterway directly from the pier, dock, or anchorage.
  - Casualties at dredging operations or at similar work activities in a channel.
  - Some casualties involving vessels at anchorage.
- Unaddressable Incidents
  - Mechanical failure, fire or explosion.
  - Non-participating vessels (i.e., fishing vessels and other vessels less than 20 meters in length).
  - Casualties outside of the VTS range of surveillance.
  - Grounding or collisions in close-quarter situations such as docking, undocking, maneuvering in a crowded anchorage.
  - Incidents which occur with insufficient warning or lead time (e.g., micro bursts).

Forecasting Future Vessel Casualties

Vessel Traffic

Vessel exposure to potential vessel casualty is measured in terms of the number of vessel transits. Vessel transits are estimated by vessel type and size moving within each of the 99 study subzones. Vessel transits for the years 1996-2010 are forecast by applying growth rates of the cargos carried by each of the several vessel types. Consideration is given to the changes in vessel sizes through the study period.

Navigational Risk

Navigational risk is represented by the number of VTS addressable casualties (collisions, groundings, and rammings), per hundred thousand vessel transits, by vessel type and size for each study subzone.

The approach taken is to develop national average vessel casualty rates for VTS addressable vessel casualties, estimated by vessel type and casualty type. The historical casualty rates for subzones with operating VTS services are adjusted to account for the beneficial effect of existing systems. They are then aggregated across all subzones and divided by the appropriate vessel transits to develop national average vessel casualty rates by casualty type, vessel type, and vessel size.

In order to produce vessel casualty probabilities representing each of 99 specific subzones, the national average casualty rates are modified by subzone risk adjustment factors that reflect local navigational characteristics. The subzone adjustment factors are generated by a multiple regression analysis of statistically significant navigational variables common to all subzones. These variables are used to represent the unique navigational characteristics in each subzone.

Forecasting Future Vessel Casualties *(cont'd.)*
The subzone probabilities of vessel casualties (by casualty type, vessel type, and vessel size) are then estimated by multiplying the national average vessel casualty rates by the subzone risk adjustment factors.

Projecting Avoidable Future Vessel Casualties
Application of the vessel casualty probabilities to the traffic forecasts permits the estimation of the probable number of future vessel casualties in each subzone excluding the VTS effects. In order to project future avoided casualties attributable to the Candidate VTS Design, VTS Effectiveness Factors reflecting different navigational situations, vessel sizes and VTS levels of technology are applied.

Estimating Avoidable Consequences, Physical Units and Dollar Values

Given estimates of vessel casualties, conditional probabilities of consequences and their respective severity levels are applied. The consequences associated with the avoided casualties are measured in physical terms and then converted to dollar values for benefit-cost analysis. The dollar values of all avoided future consequences over the 15-year life cycle are discounted back to the year of the initial investment (1993) for comparison with discounted VTS costs.

The following types of consequence are estimated using conditional probabilities derived from historical data:

Vessel Damage - These damage losses cover the repair charges as well as the opportunity costs of the idle vessels during their repair. An overall average of 40% of vessel casualties result in vessel damage.

Human Deaths/Human Injuries - An overall average of 3% of vessel casualties result in deaths and 10% in injuries.

Cargo Damage and Loss - An overall average of 11% of all vessel casualties suffer damage/loss to the cargo.

Navigational Aid Damage - The results of the analysis indicate that vessel rammings have an overall 2% probability of causing NAVAID damage.

Bridge Damage - The overall probability of bridge damage is 1% of the total vessel casualties.

Emergency Response - The Coast Guard responds to every casualty that is reported. The dollar value of these emergency responses is estimated by type of vessel and type of response required.

Hazardous Commodity Spills and Associate Losses - Environmental losses and economic losses occur when there are spills of hazardous commodities. The overall probability of hazardous spills of bulk cargos from tankers and tank barges is estimated to be 13% of these vessel casualties.

Environmental/Marine Life Loss
Estimates of avoided environmental/marine losses are provided in terms of their physical dimensions (e.g., the number of marine mammals and birds, quantity of commercial fish species lost) and their respective dollar values.

The spill damage assessment of various hazardous commodities on the environment and marine life is supported by the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME) developed by U.S. Department of the Interior. The model has been modified and applied to represent the marine species found in each of the 23 study zones. The model estimates the pounds of commercial fish species destroyed, the numbers of birds and mammals, and the economic value of these losses.

Scenarios are developed of hazardous commodity spills in each subzone, reflecting average conditions under which the spills might occur. The results for each subzone are reported in terms of the quantity and the total dollar value of all species lost per spill by subzone, hazardous commodity spilled, and spill size.

Estimating Avoidable Consequences, Physical Units and Dollar Values *(cont'd.)*

Decrease in Tourism, Recreational and Commercial Use and Value of Shoreline Properties

When spills take place, losses occur in tourism and recreational uses of coastal shoreline and waters and in the perceived value of shoreline properties that have been fowled. A model predicts the spill-related tourism and recreational losses due to spills of crude oil. Property value losses are based on rental income loss due to spills of crude oil, petroleum products, and chemicals.

Cleanup Activities

Spills of crude oil, petroleum products, and chemicals require extensive cleanup efforts to minimize their effects on the environment. Cleanup costs for several sizes of spills are estimated.

Damage Assessment

When a spill occurs, those responsible must compensate the government and the injured parties for damages to environmental resources, and for clean-up costs. They must also reimburse the federal government (DOI or NOAA) and/or state environmental agencies for their expenses in assessing the damages. Estimates of the costs of preparing these damage assessments are made for each spill size.

Liquified Natural Gas (LNG) and Liquified Petroleum Gas (LPG) Explosions

Estimates are developed of the type and amount of damage resulting from explosion and fire following a release of LNG and LPG, given the type of vessel casualty and the location of the casualty. The estimates include the damages to the tankers and their crew, other vessels and crew, local populations and structures on shore.

VTS Candidate Designs and Costs

The basic concept of the "Candidate VTS Design" includes a state of the art central data gathering and watch standing facility, known as a Vessel Traffic Center, and an array of state-of-the-art surveillance sensors covering each subzone. The Candidate VTS Design has as its objective the timely and accurate communication of critical navigational information to the bridge of participating vessels minimizing the risk of vessel casualties. The unique characteristics of each subzone dictate how many and what type of surveillance sensors (radar, television, communications, automatic dependent surveillance [ADS], etc.) support the Vessel Traffic Center.

A survey of state of the art VTS technology resulted in a list of 18 modules of surveillance and communications technologies ranging from high performance radar to closed circuit TV. The Candidate VTS Design for each study zone is defined by a unique selection of these modules. The appropriate surveillance modules are selected on the basis of engineering judgment of the local requirements for the purpose of developing cost estimates that are consistent and comparable among the 23 study zones. The costs of the Candidate VTS Design are then estimated, including non-recurring initial capital investment and recurring operations and maintenance costs. Initial capital investments range from $3.3 million for Portsmouth, NH, to $25.5 million for New Orleans. In the four study zones where there are existing Coast Guard VTS services, selected existing facilities are incorporated into the Candidate VTS Design, thus reducing the initial investment cost for those zones.

Evaluation of VTS Benefits and Costs

The final product of this study is the estimated net benefit of a Candidate VTS Design in each of 23 study zones. The net benefit is the difference between the 1993 value of the life cycle benefits and costs.

The net benefit in each study zone assumes that the decision to implement is made and that the funds are appropriated in FY '93. The Candidate VTS Design is assumed to be fully operational (accruing operations and maintenance costs as well as

Evaluation of VTS Benefits and Costs *(cont'd)*

benefits) by the beginning of FY '96. The life cycle period is assumed to run through FY 2010.

Two perspectives are analyzed and compared:

1) The full benefits and costs of the Candidate VTS Design, i.e., ignoring any existing VTS services.

2) The marginal benefits and costs of the Candidate VTS Design (acknowledging the benefits and costs of Existing VTS Services) that would accrue if the existing system continued unchanged into the future.

These Existing VTS Services include Coast Guard VTS systems and commercial VTS-like services.

Full VTS Benefits and Costs

The full benefits can be viewed as the difference between the projected casualties in an unimproved study zone and the casualties with a Candidate VTS Design (i.e., the Avoided Casualties). The full benefits can be estimated by application of VTS Effectiveness Factors to the projected vessel casualties and associated consequences/losses of the unimproved situation. The full costs of the Candidate VTS Design are the "Clean Sheet" costs (i.e., no existing facilities incorporated into the Candidate VTS Design). The benefits and costs of all 23 study zones are estimated this way, and they are compared on this basis.

Marginal VTS Benefits and Costs

Marginal benefits and marginal costs are defined for assessing the benefits and costs of the Candidate VTS Design over the *status quo* in those study zones where existing vessel traffic services are currently in operation. Marginal benefits are developed for those study zones by estimating *the differences* in the Candidate VTS Design avoided vessel casualties and the avoided vessel casualties if the Existing VTS system continues unchanged into the future. This difference is defined as the marginal benefit. The marginal VTS Costs are defined to incorporate both the incremental investment associated with utilization of certain existing Coast Guard facilities (e.g., radar facilities in Puget Sound) into the Candidate VTS Design and the differences in the annual operation and maintenance costs.

Projected VTS Benefits

The following sections present the national aggregate benefits for the 15-year period, 1996-2010 and the study zones ranked by each major benefit type. The figures present both the Full Benefit and the Marginal Benefit for each study zone.

In order to assess the overall value of the Candidate VTS Design in all 23 study zones to the nation as a whole, the national total physical losses, the undiscounted dollar values, and the 1993 discounted value of the net benefits are examined in sequence. It is informative to view several of the major loss categories at the national aggregate level prior to considering the ranking of the individual study zones by the 1993 value of the net benefits.

In the nine study zones that had operating Existing VTS Systems during 1990, the upper bar on each figure indicates the Full Benefit of the Candidate VTS Design, and the lower bar indicates the Marginal Benefit.

Avoided Vessel Casualties

The Candidate VTS Designs for the 23 study zones are projected to avoid a total of 980 vessel casualties during the 15-year period. This represents a 29% decrease in addressable vessel casualties than would occur without any VTS. VTS is more effective in avoiding collisions than it is in avoiding rammings and groundings. Therefore, 53% of the avoided vessel casualties are collisions. Rammings and groundings represent a combined total of 47% of the avoided vessel casualties.

Figure 2 displays the 23 study zones in descending order of avoided vessel casualties. New Orleans overwhelmingly leads with 4.5 times as many as Port Arthur. In New Orleans, 56% of the avoided vessel casualties involve barge tows (i.e., 33% barge collisions and 23% barge rammings and groundings).

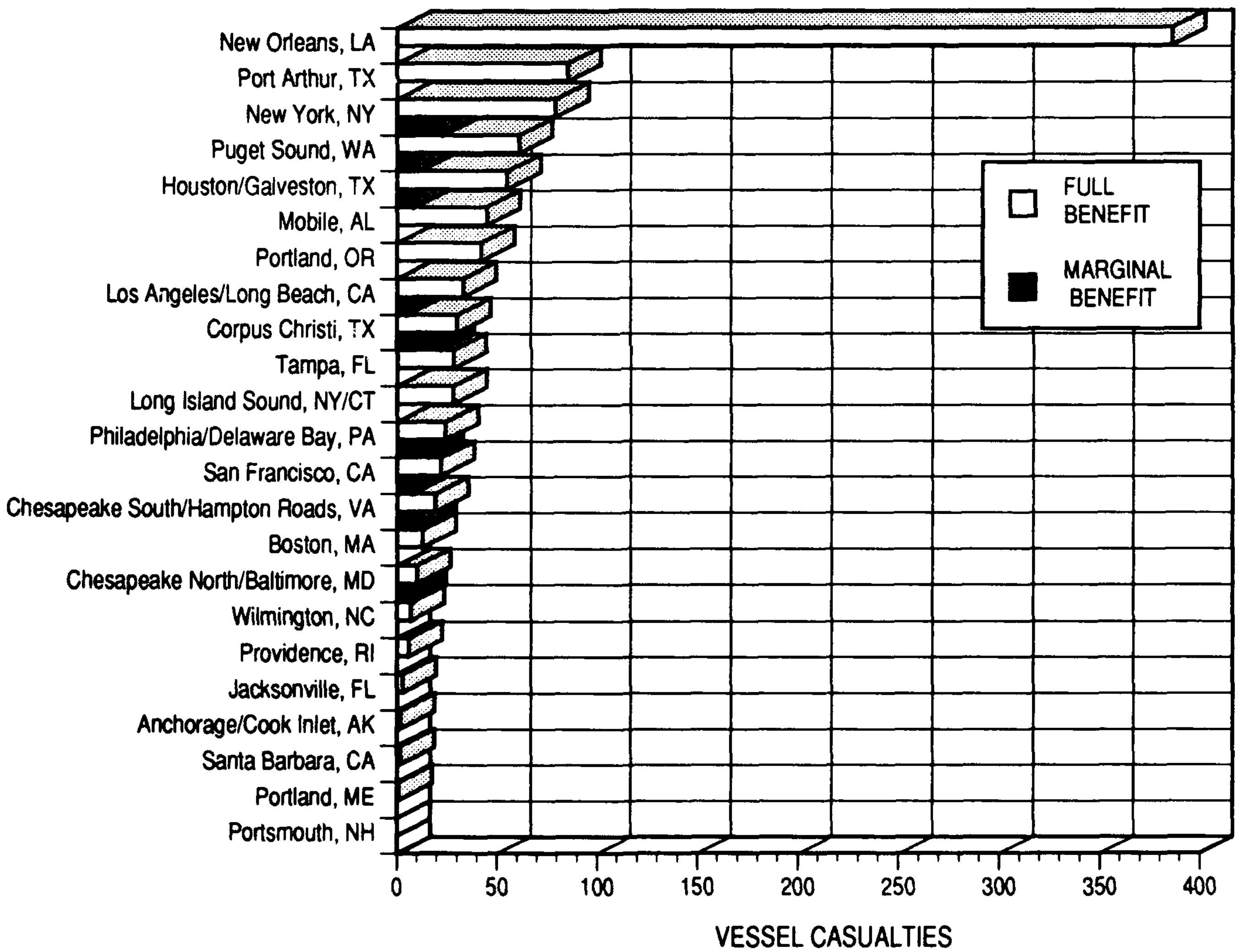


Figure 2: Avoided Vessel Casualties

Avoided Human Injuries and Deaths

If all 23 Candidate VTS Designs are implemented, a total of 138 injuries and 31 human fatalities can be avoided during the 15-year period.

Figure 3 displays the 23 study zones in descending order of avoided human injuries and deaths. New Orleans leads with 50 avoided deaths and injuries, followed by Puget Sound with 33 and New York with 14 avoided deaths and injuries.

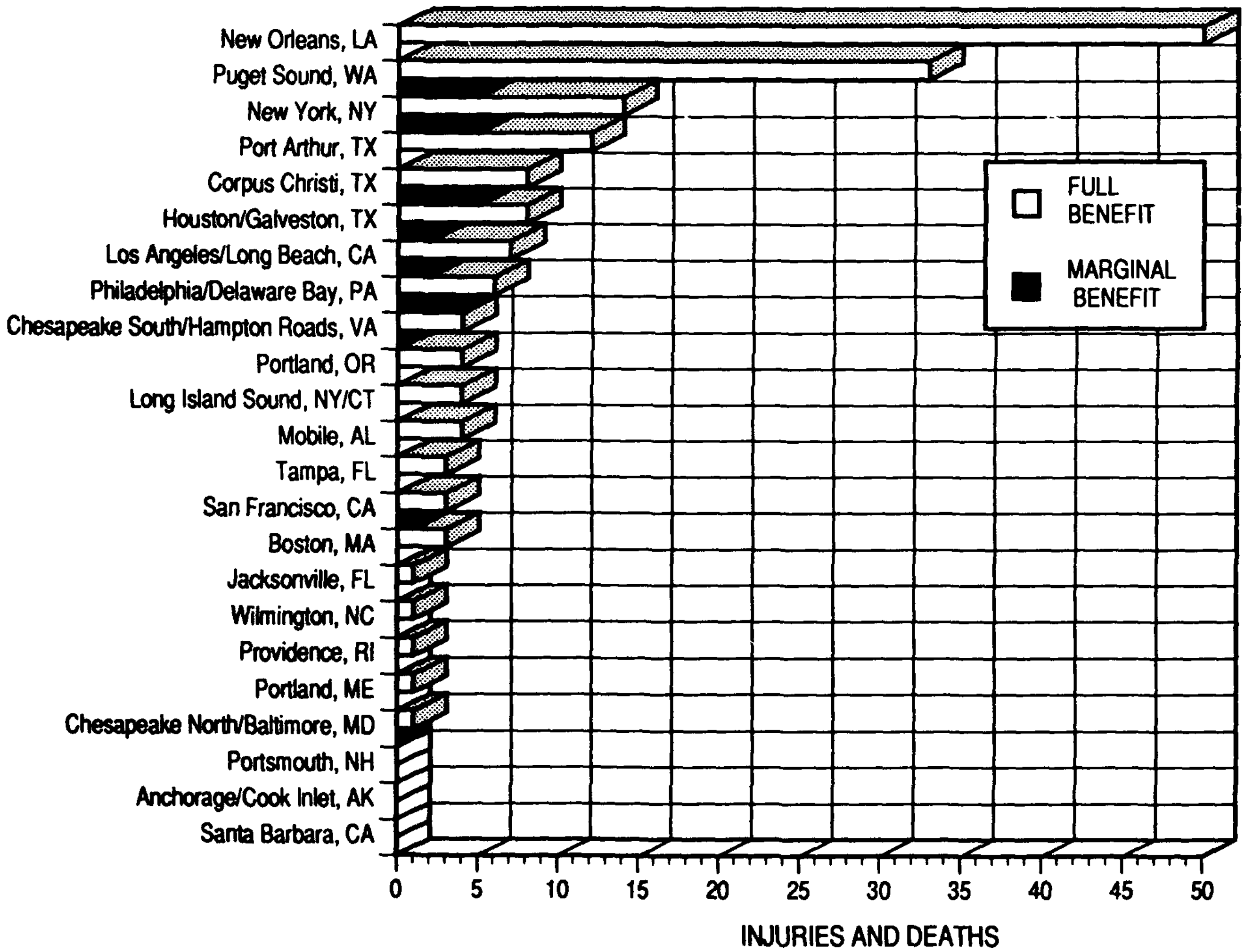


Figure 3: Avoided Human Injuries and Deaths

Avoided Hazardous Commodity Spills

If all 23 study zones implement the Candidate VTS Designs, a total of 100 hazardous commodity spills of all sizes can be avoided during the 15-year period. This includes bulk cargo spills from tankers and tank barges and vessel fuel (bunker) spills from all vessel types involved in vessel casualties resulting in vessel damage. In each of the top four zones, over 80% of the spills are 10,000-750,000 gallons each.

Figure 4 displays the 23 study zones in descending order of avoided hazardous commodity spills. New Orleans overwhelmingly leads with 40 avoided hazardous commodity spills. New York, Houston/Galveston and Puget Sound each have 8 avoided spills.

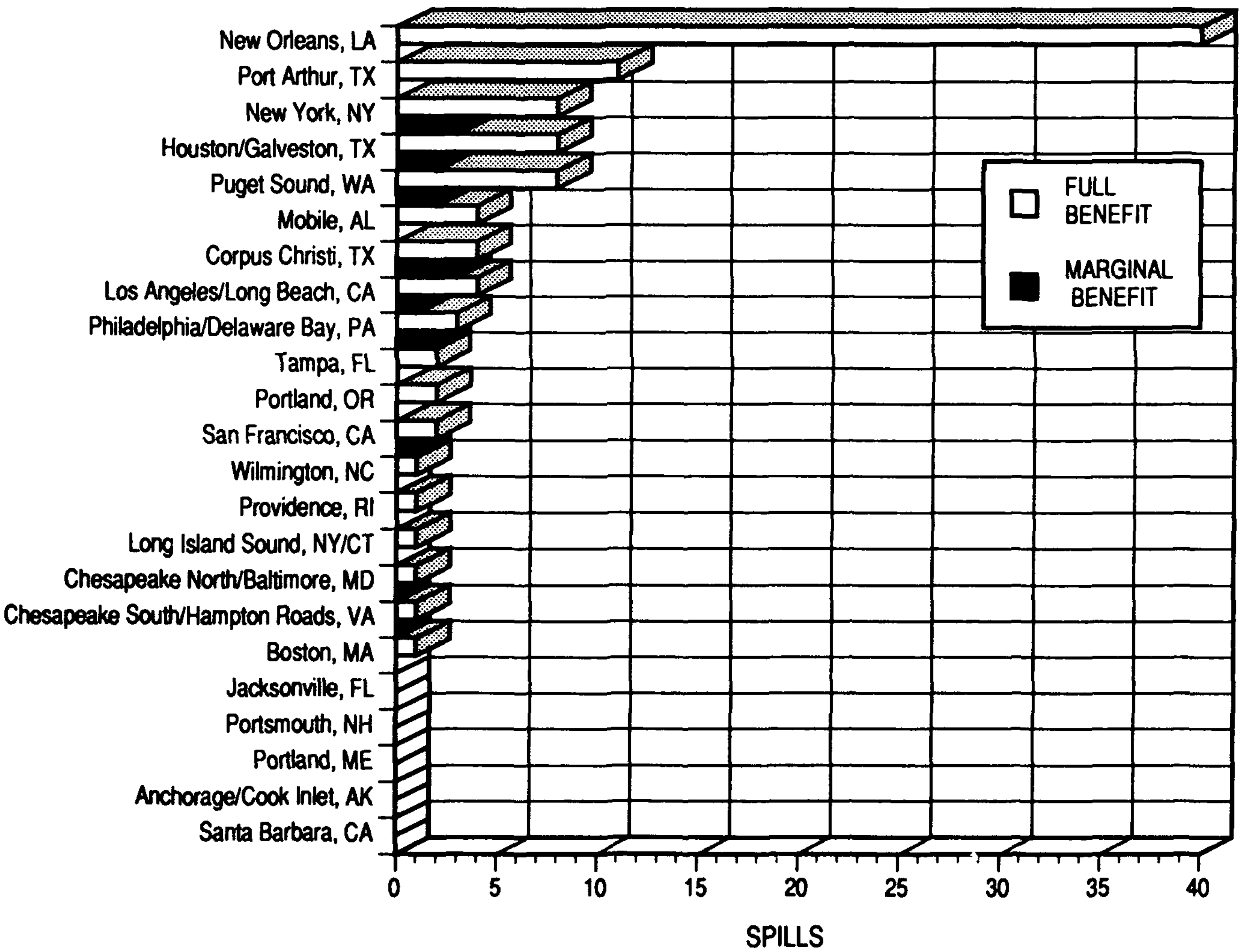


Figure 4: Avoided Hazardous Commodity Spills

Avoided Marine Mammal and Bird Losses from Hazardous Commodity Spills

Hazardous Commodity Spills result in environmental and commercial losses. If all 23 study zones implement the Candidate VTS Designs, a loss of 3.9 million individual marine mammals and birds from hazardous commodity spills can be avoided during the 15-year period.

Figure 5 displays the 23 study zones in descending order of avoided marine mammal and bird loss to hazardous commodity spills. New Orleans leads with 1.6 million. Los Angeles/Long Beach has 550 thousand, Port Arthur has 522 thousand, and New York has 209 thousand individual marine mammal and bird losses from hazardous commodity spills.

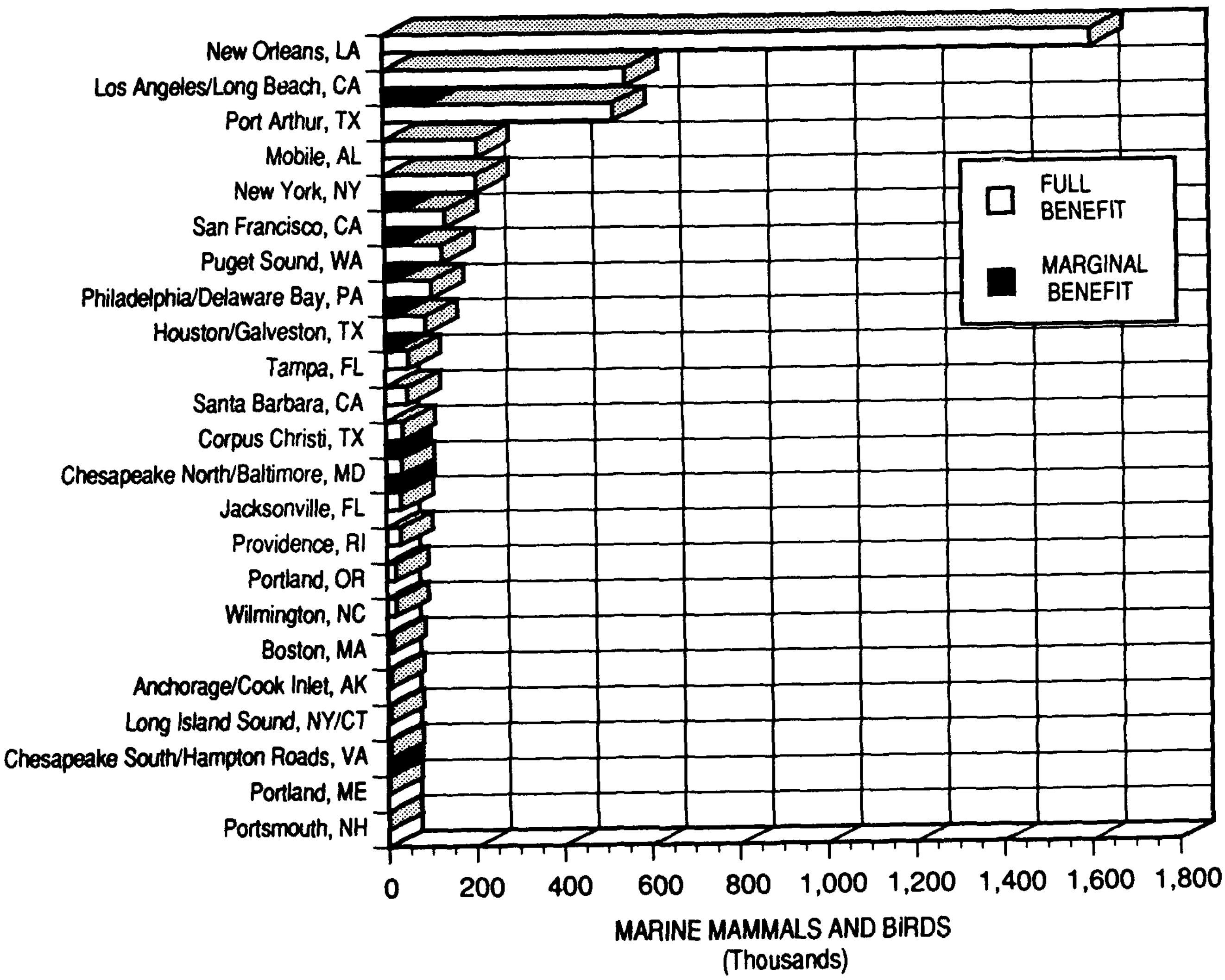


Figure 5: Avoided Marine Mammal and Bird Losses from Hazardous Commodity Spills

Avoided Commercial Fish Species Losses from Hazardous Commodity Spills

If all 23 study zones implement the Candidate VTS Design, a total of 396 million pounds of commercial fish species losses can be avoided during the 15-year period.

Figure 6 displays the 23 study zones in descending order of avoided commercial fish species losses from hazardous commodity spills. Houston/Galveston leads with 176 million pounds; Port Arthur and New Orleans follow with 67 million pounds each of commercial fish species losses from hazardous commodity spills.

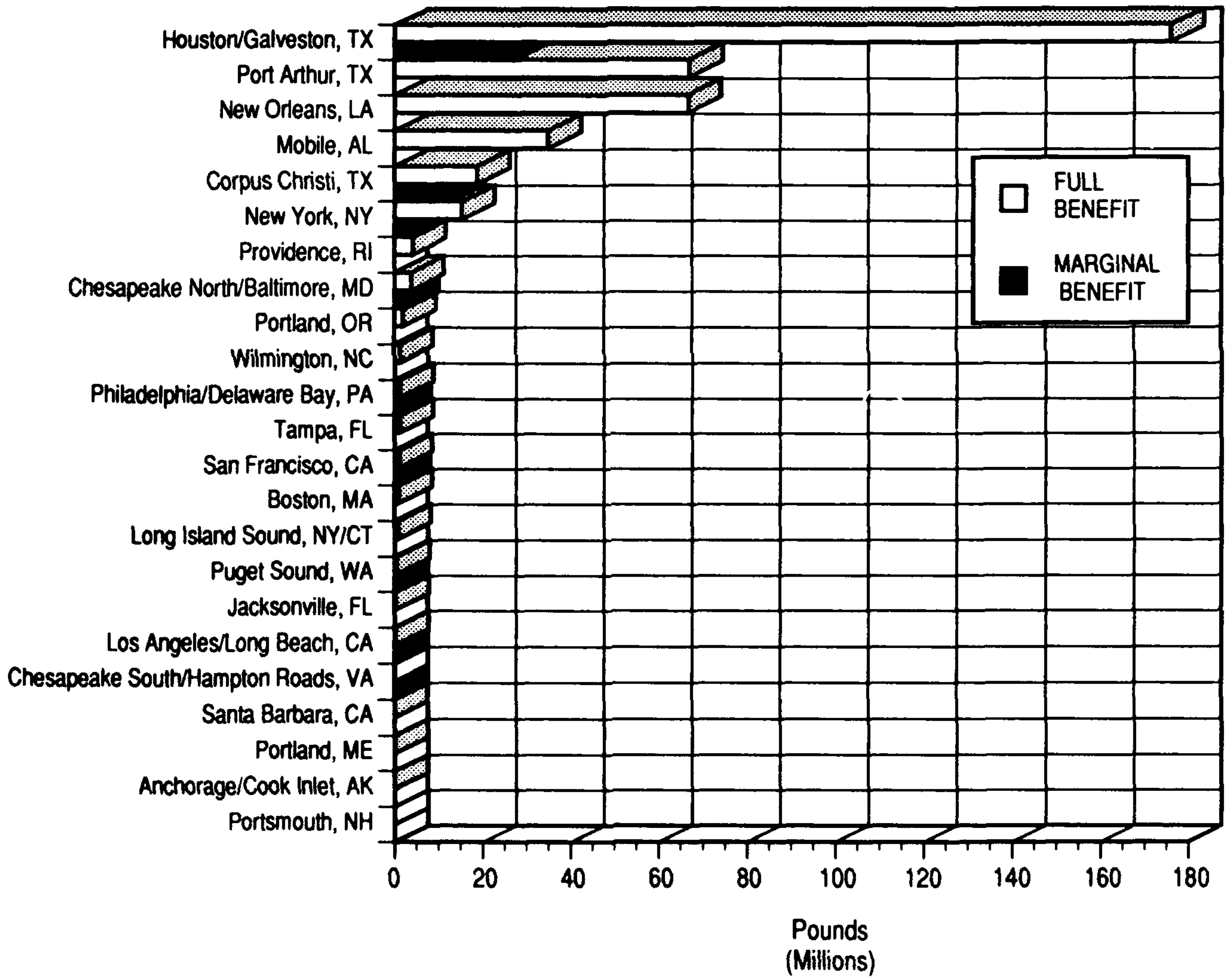


Figure 6: Avoided Commercial Fish Species Losses from Hazardous Commodity Spills

Avoided Dollar Losses of All Consequences - (Undiscounted 15 Year Total)

When all avoided vessel casualty consequences attributed to the 23 Candidate VTS Designs are converted to constant dollar values, the 15-year avoided losses total $1.9 billion (undiscounted).

Figure 7 displays the 23 study zones in descending order of total avoided dollar losses attributed to the Candidate VTS Designs. New Orleans, Port Arthur, Houston/Galveston, are responsible for 60% of this total; Mobile, Los Angeles/Long Beach, New York, and Corpus Christi, for an additional 23%. The first seven study zones are responsible for 83% of the total potential avoided dollar losses (undiscounted), attributed to the 23 Candidate VTS Designs. Figure 7 also displays the dollar values of the avoided losses attributed to the 9 Existing VTS Systems to highlight the incremental increases offered by the candidate VTS in those study zones.

Losses associated with hazardous commodity spills are responsible for 74%-94% of the total avoidable dollar losses in each zone. In each of these zones, cleanup costs are a large portion of the spill costs. However, in Los Angeles/Long Beach, property losses associated with spills reaching shore dominate. In Houston/Galveston and Mobile, the commercial fish species losses and cleanup costs dominate.

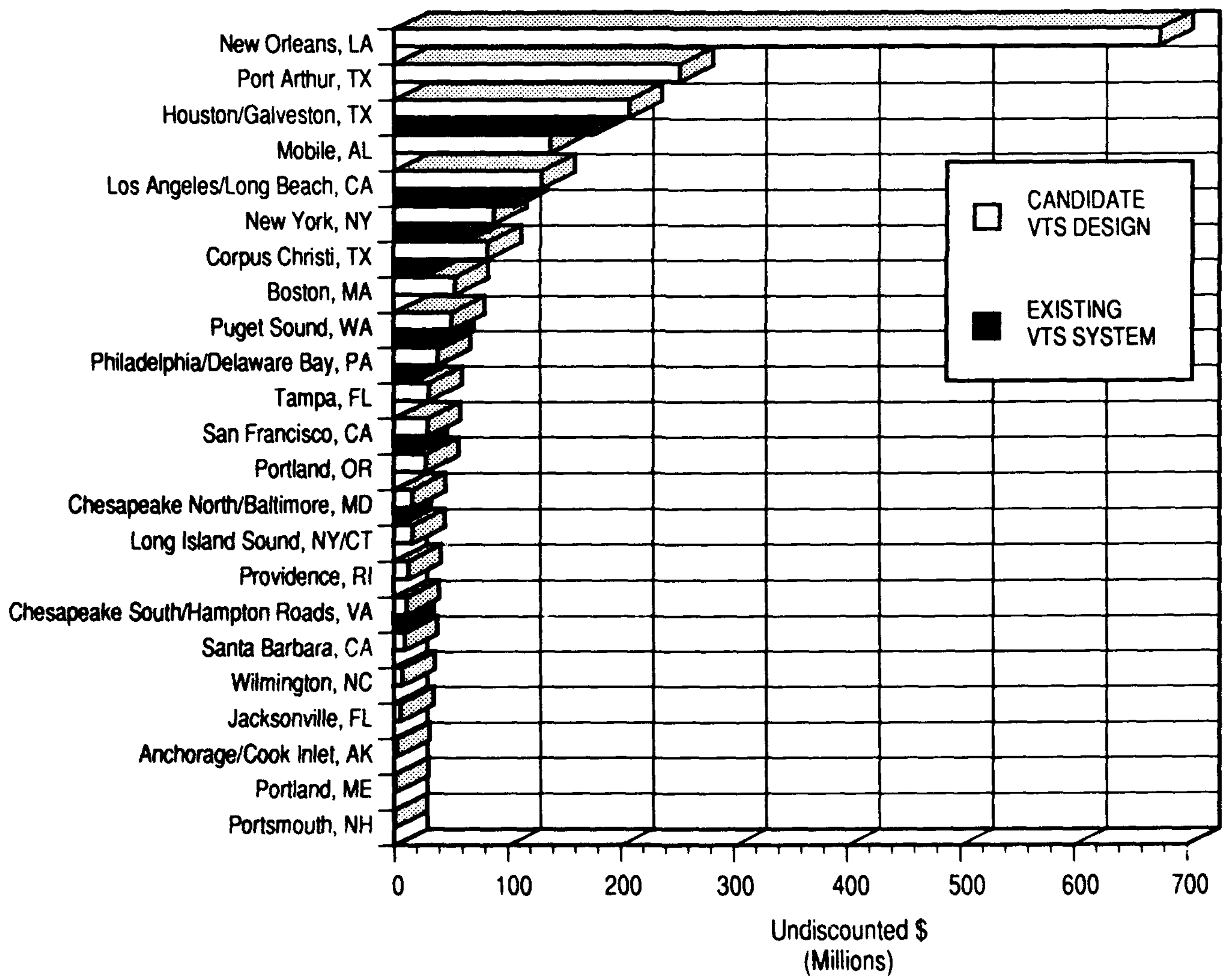


Figure 7:
Avoided Dollar Losses of All Consequences - (Undiscounted 15 Year Total)

Projected VTS Net Benefit

The 1993 discounted value of the 15-year life cycle Net Benefit (i.e., discounted annual stream of benefits minus the discounted annual stream of VTS investment and O&M costs) transforms all future benefits and costs to a single objective measure suitable for ranking the 23 study zones in terms of the aggregate national interest.

Table 1 lists the 23 study zones in the order of the study zone code number and displays the 1993 value of the total life cycle total benefits, total costs, and net benefits for the Candidate VTS Designs in each study zone. The benefits and costs are discounted to the beginning of FY 93, the time of the initial commitment of the VTS investment. The annual streams of VTS benefits and O&M costs begin in FY 96 and continue through FY 2010.

Table 1.
Study Zone 1993 Value of Life Cycle Benefit & Cost

ZONE	NAME	TOTAL BENEFIT ($1,000's)	TOTAL COST ($1,000's)	NET BENEFIT ($1,000's)
1	Boston, MA	23,149	7,999	15,150
2	Puget Sound, WA	21,717	25,724	(4,007)
3	Los Angeles/Long Beach, CA	55,848	13,021	42,827
4	Santa Barbara, CA	3,888	8,667	(4,779)
5	Port Arthur, TX	108,270	15,856	92,414
6	New Orleans, LA	290,771	37,036	253,735
7	Houston/Galveston, TX	89,661	28,646	61,014
8	Chesapeake South/Hampton Roads, VA	4,531	22,918	(18,387)
9	Chesapeake North/Baltimore, MD	6,924	8,593	(1,669)
10	Corpus Christi, TX	35,424	9,311	26,113
11	New York, NY	35,480	26,445	9,036
12	Long Island Sound, NY/CT	6,837	9,084	(2,248)
13	Philadelphia/Delaware Bay, PA	16,221	14,032	2,189
14	San Francisco, CA	12,694	22,624	(9,930)
15	Portland, OR	11,850	9,647	2,203
16	Anchorage/Cook Inlet, AK	935	14,473	(13,538)
17	Portland, ME	410	7,687	(7,277)
18	Portsmouth, NH	23	6,107	(6,084)
19	Providence, RI	5,281	7,265	(1,984)
20	Wilmington, NC	2,939	7,586	(4,647)
21	Jacksonville, FL	2,473	6,421	(3,948)
22	Tampa, FL	13,185	8,008	5,176
23	Mobile, AL	57,747	9,606	48,141
Totals		806,225	326,756	479,449

Projected VTS Net Benefit *(cont'd.)*

Figure 8 displays the 23 study zones in descending order of the Net Benefit. In the nine study zones with operating Existing VTS Systems, the upper bar indicates the full Net Benefit of the Candidate VTS Design, and the lower bar the marginal Net Benefit.

Considering the Full Net Benefit, the first 11 study zones are positive and the next 12 are negative. Viewing from the perspective of the Marginal Net Benefit, the rank order changes somewhat. The most significant changes are Los Angeles/Long Beach, which shifts from a substantial positive net benefit to a slightly negative benefit and Puget Sound which changes from a negative net benefit to a substantially positive net benefit. The positive marginal net benefit in Puget Sound reflects the fact that the reduction in annual O&M cost exceeds the incremental investment for the Candidate VTS Design in that study zone. Philadelphia/Delaware Bay, with the lowest positive full net benefit, changes to a negative when the marginal net benefit is considered.

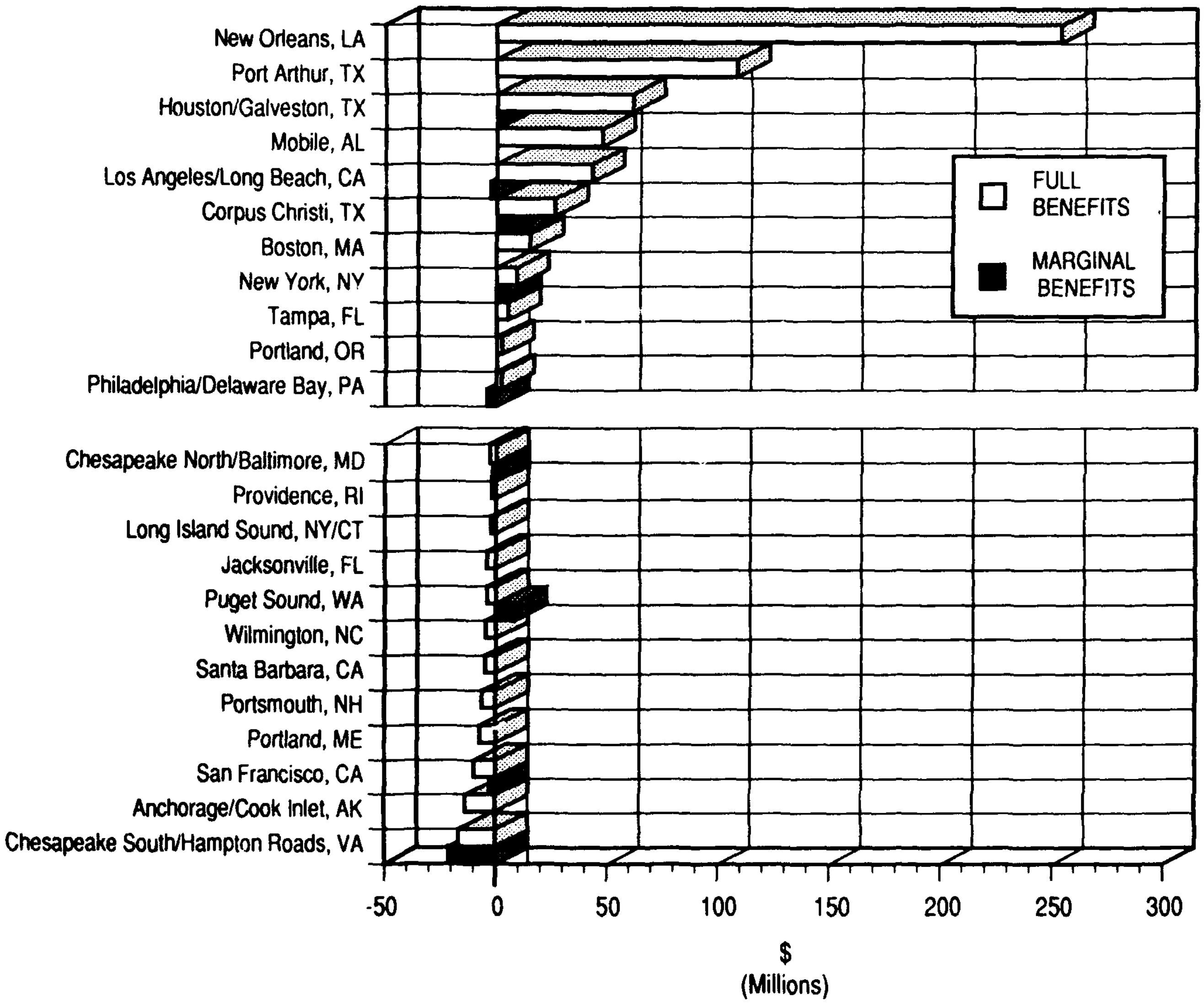


Figure 8: 1993 Value of Projected VTS Life Cycle Net Benefits

Sensitivity

Uncertainty of Study Variable Estimates

The study evaluates the sensitivity of the relative net benefits among the 23 study zones to any uncertainty relating to selected major input variables. The analysis first takes a global perspective of the analytical process and tests selected inputs for all 23 study zones concurrently.

The sensitivity of the net benefits to any uncertainty relative to selected major variables is examined first by varying the VTS costs and the VTS benefits by fixed percentages.

The effect of a 50% increase in the estimated VTS costs in each zone results in minor changes in the rank order of the 23 study zones. The most significant change is that New York, Portland, OR, and Philadelphia/Delaware Bay shift from a positive to a negative net benefit.

The effect of a 50% reduction in the estimated total benefit in each zone results in some changes in the rank order. The most significant change is that New York, Tampa, Portland, OR, and Philadelphia/Delaware Bay shift from a positive to a negative net benefit.

The effect of a 50% increase in the estimated total benefit in each zone also results in some changes in the rank order. The most significant change is that Puget Sound, Chesapeake North/Baltimore, Long Island Sound and Providence each shift from a negative to a positive net benefit.

Sensitivity *(cont'd.)*

Zone Specific Dominant Avoided Losses

In addition to the sensitivity of the relative net benefits across all 23 study zones to the basic analytical methods and input data, there may be some concern over estimates of selected types of VTS avoided losses in one or more of the study zones. To address this concern, the focus shifts to the individual study zone's net benefits and the specific loss type(s) that dominate the VTS benefits in each of these zones.

Considering the Full (rather than the Marginal) Net Benefit, the sensitivity of the net benefits may be assessed in terms of the study zone's respective dominant loss type and the effect that any uncertainty about that loss might have on the net benefit, and the rank order.

Table 2 lists the study zones in rank order by Net Benefit and highlights the dominant categories of avoided losses in each zone.

Table 2. Rank Order by Net Benefit

Rank	Zone	Net Benefit (millions)	Largest Avoided Loss
1.	New Orleans	$254	Hazardous commodity spills cleanup (50% of total)
2.	Port Arthur	$92	Hazardous commodity spills cleanup (48% of total)
3.	Houston/Galveston	$61	Commercial fish species (42% of total) and cleanup (30% of total)
4.	Mobile	$48	Hazardous commodity spills cleanup (38% of total) and commercial fish species (34% of total)
5.	Los Angeles/Long Beach	$43	Property damage from hazardous commodity spills (55% of total)
6.	Corpus Christi	$26	Hazardous commodity spills cleanup (40% of total) and commercial fish species (29% of total)
7.	Boston	$15	LNG explosion damage (63% of total). LNG loss is the dollar value of all deaths, injuries, and material losses associated with LNG explosions during the 15-year period (i.e. a total expected value of 0.016 or an average annual expected value of 0.0011 which translates to approximately one probable LNG explosion in 1,000 years). The probability of an LNG vessel casualty (which is assumed to precede an explosion) is estimated at 10% of other large tankers in the zone.
8.	New York	$9	Hazardous commodity spills cleanup (55% of total)
9.	Tampa	$5	Hazardous commodity spills cleanup (52% of total)
10.	Portland, OR	$2	Hazardous commodity spills cleanup (47% of total), property damage (15% of total) and vessel damage (15% of total)
11.	Philadelphia/Delaware Bay	$2	Hazardous commodity spills cleanup (60% of total)

Table 2. Rank Order by Net Benefit *(cont'd)*

Rank	Zone	Net Benefit (millions)	Largest Avoided Loss
12.	Chesapeake/North Baltimore	($2)	Hazardous commodity spills cleanup (36% of total) and commercial fish species (37% of total)
13.	Providence,RI	($2)	Hazardous commodity spills cleanup (48% of total)
14.	Long Island Sound	($2)	Hazardous commodity spills cleanup (50% of total)
15.	Jacksonville	($4)	Hazardous commodity spills cleanup (47% of total)
16.	Puget Sound	($4)	Hazardous commodity spills cleanup (37% of total) and vessel damage losses (18% of total)
17.	Wilmington, NC	($5)	Hazardous commodity spills cleanup (45% of total) and vessel damage (18% of total)
18.	Santa Barbara	($5)	Property damage (54% of total)
19.	Portsmouth, NH	($6)	Vessel damage (40% of total) and cleanup (33% of total)
20.	Portland, ME	($7)	Hazardous commodity spills cleanup (48% of total)
21.	San Francisco	($10)	Hazardous commodity spills cleanup (45% of total)
22.	Anchorage/Cook Inlet	($14)	Hazardous commodity spills cleanup (50% of total)
23.	Chesapeake South/ Hampton Roads	($18)	Hazardous commodity spills cleanup (45% of total)

In each of these study zones, the effect of the level of uncertainty with respect to the dominant loss type(s) on the net benefit can be estimated by application of a factor to each dominant loss type considered suspect. This level of sensitivity analysis may be conducted by the reader in conjunction with a review of the detailed study zone specific statistics presented in the appendix tables, Volume II, of the study final report.

Findings

The study indicates that the 23 study zones can be divided into three groups in terms of their relative life cycle net benefits. Analysis of the sensitivity of the relative values of net benefits to underestimates or overestimates of the VTS benefits or the VTS costs suggests the following groupings. The first seven zones have a positive net benefit over the range of uncertainty tested.

Positive Net Benefit:

- New Orleans
- Port Arthur
- Houston/Galveston
- Mobile
- Los Angeles/Long Beach
- Corpus Christi
- Boston

The net benefits of the following eight zones may be considered sensitive because their relative values are comparatively small, and may be positive or negative over the range of uncertainty tested.

Sensitive Net Benefit:

- New York
- Tampa
- Portland, OR
- Philadelphia/Delaware Bay
- Chesapeake North/Baltimore
- Providence
- Long Island Sound
- Puget Sound

The following eight study zones retain their negative net benefit status over the range of uncertainty tested.

Negative Net Benefit:

- Jacksonville
- Wilmington
- Santa Barbara
- Portsmouth
- Portland, ME
- San Francisco
- Anchorage/Cook Inlet
- Chesapeake South/Hampton Roads